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ECONOMIC NOTES NO. 6 JULY 1937

THE FOREST SITUATION IN THE HARDWOOD AND PRAIRIE DISTRICTS OF MINNESOTA

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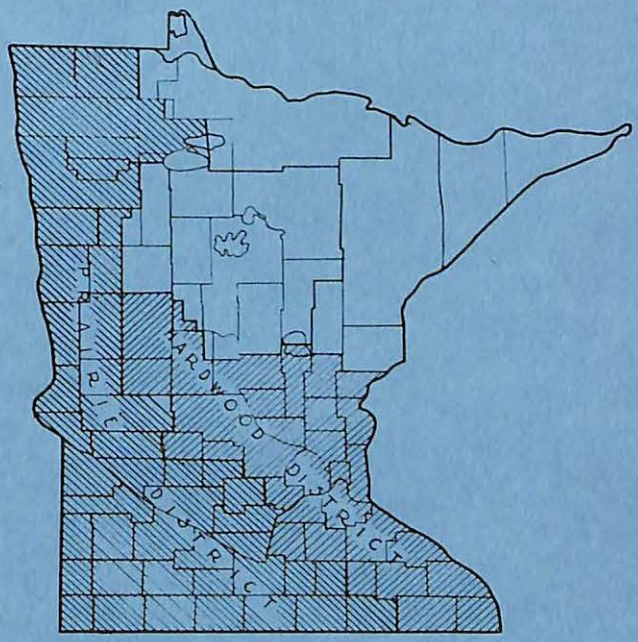

PRELIMINARY STATISTICS AND ANALYSIS OF DATA OBTAINED FROM FOREST SURVEY AND NEW PUBLIC DOMAIN STUDIES BY THE

LAKE STATES FOREST EXPERIMENT STATION
UNIVERSITY FARM — ST. PAUL MINNESOTA
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

INDEXED

Preliminary Report of the

LAKE STATES FOREST EXPERIMENT STATION[1/]

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[1/] Maintained by the U. S. Department of Agriculture at University Farm, St. Paul, Minnesota, in cooperation with the University of Minnesota.

Economic Notes No. 6 July 1937

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FOREWORD

Fundamental to sound planning in either public or private forestry are reliable basic data on the local and national timber situations.

From time to time, estimates have been made of the volume of timber left standing in the country. Current rate of growth has been computed and contrasted with the rate of depletion, and forecasts made of future timber needs. At no time, however, until the National Forest Survey was authorized by the McSweeney-McNary Act in 1928, was any systematic effort made to carry on a complete field survey to gather the needed information. The present forest survey, which is now under way in most of the important forest regions of the country, is such a field survey. The fivefold aim of the survey is:

1. Inventory. To take stock of the supply of timber and other forest products and the areas of land available for growing timber. This information is collected by natural economic units tributary to certain groups of wood-using industries. Ownership and availability of the timber are also considered.

2. Growth. To ascertain the current rate of growth and the growth prospects under different types of management -- mere protection, extensive management, and intensive management.

3. Drain. To determine the rate of depletion from industrial and local timber use, windfall, fire, insects, and disease.

4. Requirements. To determine the present consumption and the probable future trend in the requirements for timber and other forest products.

5. Policies and plans. To correlate these findings with existing and anticipated economic conditions in order that policies can be formulated for the effective use of land available for forest production.

CONTENTS

	Page
Foreword	II
The Survey findings in brief	1
Section 1. The forestry background	3
Distinctive characteristics of the area	3
Intensive land use	3
Recreation and water conservation	4
The erosion problem	5
Shelterbelts	6
The need for forests	7
Forest history	7
Original forests	7
Depletion	8
Section 2. Present forest conditions	9
Areas and per-acre volumes	9
Total volumes	14
Depletion	15
Cutting	15
Fire	15
Grazing	16
Insects and diseases	16
Drought	16
Winds	16
Land clearing	17
Depletion per acre	17
Growth	17
Growth versus depletion	19
Section 3. Wood requirements and forest utilization	21
Industrial requirements	21
Lumber	21
The sawmill situation	22
Railroad cross ties	23
Pulp and paper	23
Other wood-using industries	24
Forest utilization	24
Posts	24
Fuel wood	25
Other forest products	26
Section 4. Measures to improve the situation	28
Causes of poor forest management	28
Forest-management technique	28
Cutting methods	28
Cultural measures	29
Planting	29

Page

Section 4. Measures to improve the situation — Continued
Causes of poor forest management — Continued
Economic conditions 29
Taxes 30
Marketing 31
Pasturing as a competitive use 31
Tenancy 31
Public attitude 32
Possible remedies 32
Education 32
Extension 33
A stimulating farm example 34
State and Federal aid 34
Research 35

Literature cited 37

Appendix 39
Table I. Classification of land according to U. S. census of agriculture 39
Table II. Area of forest land 40
Table III. Summary of timber volume 42
Table IV. Average volume of timber per acre 43
Table V. Volume of saw timber, Hardwood District 44
Table VI. Volume of saw timber, Prairie District 45
Table VII. Volume of pulpwood 46
Table VIII. Average acres of northern-hardwood types 47
Table IX. Average acres of oak cordwood and wooded pastures .. 48
Table X. Primary wood-using industries, including number of mills, employment, and production 49
Table XI. Lumber production of sawmills 50
Table XII. Estimated annual cut of all merchantable products .. 51
Table XIII. Estimated annual cut of merchantable sawlog products, Hardwood District 52
Table XIV. Estimated annual cut of merchantable sawlog products, Prairie District 53
Table XV. Estimated annual cut of merchantable cordwood products, Hardwood District 54
Table XVI. Estimated annual cut of merchantable cordwood products, Prairie District 55
Table XVII. Estimated annual depletion of timber, Hardwood District 56
Table XVIII. Estimated annual depletion of timber, Prairie District 57
Table XIX. Estimated annual growth of timber, Hardwood District 58
Table XX. Estimated annual growth of timber, Prairie District 59
Table XXI. Comparison of annual growth with annual depletion of timber 60

THE SURVEY FINDINGS IN BRIEF

1. In spite of the large demand for wood in the Hardwood and Prairie Districts of Minnesota, and in spite of the recognized need for woodlands for timber production, game conservation, soil protection, and as windbreaks, most forest lands in these districts are being badly managed.

2. Only 1 farm wood lot out of 100 in the Hardwood District is well managed for sustained yield. Eighty-five percent are more or less pastured, and 36 percent have been so heavily grazed that they retain only a few scattered, scrubby trees.

3. Planted shelterbelts in the Prairie District are likewise in bad condition. Only 1 farm out of 25 has a really good plantation. Fourteen percent of the farms have no protection from trees, and 58 percent more have very meager protection Poor planting, poor selection of species, lack of cultivation and care, premature cutting, grazing, and drought have left most shelterbelts in a deplorable condition.

4. Of 32,208,000 acres of land in the Hardwood and Prairie Districts, nearly 4,248,000 acres, or 13.2 percent, is woodland (including shelterbelt plantations). About one-third of this forest area, or 1,332,000 acres, consists of valuable hardwood and conifer types. The balance is aspen, scrub oak, nonproductive swamp, or brush land. Even the hardwood lands are mainly understocked and unmerchantable in size and quality of timber. The average acre of hardwood saw timber has only 3,267 board feet of merchantable sawlogs.

5. Only about 5 percent of the original stand, or 1-3/4 billion board feet of timber, remains in this part of Minnesota. This is almost exclusively hardwood, practically all the pine having been cut in early logging operations. There is but 85 million board feet of softwood timber remaining in the Hardwood and Prairie Districts.

6. At present the average annual depletion of saw timber is 73,390,000 board feet. One-sixth of this depletion results from fire and other partially preventable causes. In smaller trees the average depletion is 540,420 cords, of which more than one-third is from fire, insects, and disease. The combined depletion is 62½ million cubic feet of merchantable wood.

7 To offset depletion, average annual growth amounts to 64,380,000 board feet of saw timber, or 58½ million cubic feet of all products. Thus the wood supply, already seriously depleted, is dwindling yearly.

8. Lumber production, which now averages about 36 million board feet per year, amounts to but 1.7 board feet per capita, and of course falls far short of meeting the requirements of the districts for lumber and other items of consumption. There is similarly a shortage in production of ties, pulpwood, poles, and even fence posts and fuel wood on many farms.

9. Annual growth, which averages only 30 to 50 board feet per acre even in the more productive types, could readily be doubled and the rate of depletion materially reduced by the adoption of better cutting methods and the establishment of an effective system of protection from fire and grazing.

10. There are certain physical and economic handicaps to adoption of the best forest-management practices in the immediate future, but these can be overcome gradually by a sensible program of education, public aid, and research. Suggestions for such a program are embodied in this report.

THE FOREST SITUATION IN THE HARDWOOD AND PRAIRIE DISTRICTS OF MINNESOTA

Section 1. -- THE FORESTRY BACKGROUND

Distinctive Characteristics of the Area

The State of Minnesota lies at the convergence of four natural zones: the northern coniferous forest of Canada, the northern-hardwoods forest of Michigan and Wisconsin, the oak forest of the Central States, and the grasslands of the Great Plains. The coniferous forest region, extending through most of 16 counties in the northeastern part of the State, has been described in part in two earlier Forest Survey reports.[1/] This report deals with the Hardwood District, which borders the spruce and pine areas, and with the Prairie District, which occupies the western part of the State.

The Hardwood District embraces a gross land area of 11,356,000 acres; the Prairie District, 20,852,000 acres. Together the two districts comprise about two-thirds of the area of Minnesota.

The Hardwood and Prairie Districts of Minnesota are primarily an agricultural region and, as such, contrast markedly with the northeastern forest region. Several points of contrast have an important bearing upon the forest situation.

Intensive Land Use.

Of the 2,563,953 residents of Minnesota in 1930 (8)[2/], 84 percent lived in the agricultural region. The average density of population in this area was 43 persons per square mile, as contrasted with 14 per square mile in the northeast. Rural population averaged 26 per square mile in southern and western Minnesota, 7 per square mile in the northeastern section. The heavier demand for building material, box lumber, paper, and other products is therefore in the Hardwood and Prairie Districts.

Favorable soil, climate, and market facilities have stimulated farm development in southern Minnesota, and 89 percent of the land is now in farms. In the north a shorter growing season, poorer soil, and natural obstacles such as swamps and rock outcrop have restricted agricultural

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1/ Economic Notes No. 2, Forest Situation in the Cloquet-Superior District, Minnesota; Economic Notes No. 3, Forest Situation in the Central Pine District, Minnesota.

2/ Reference is made by numbers in parentheses (underlined) to Literature Cited, p. 37.

development (3): only 23 percent of the land is in farms, and only half of this is cleared. The concentrated agricultural development in the south creates a market not only for lumber and finished forest products but also for poles, posts, fuel wood, and other rough wood products which can be cut directly from the wood lot.

Industrial development, too, is more advanced in the southern counties, especially in the vicinity of the Twin Cities. Here are planing industries which use wood as a raw material.

Hand in hand with agricultural and industrial expansion has gone the development of transportation facilities. Eighty percent of the State's total railroad mileage and the same proportion of its highway mileage is in the Hardwood and Prairie Districts. There is, on the average, 0.31 mile of railroad and trunk highway per square mile in the agricultural districts, but only 0.14 mile per square mile in the forest districts. Secondary roads present a similar contrast. Except in the comparatively wild townships bordering the forest districts, there is scarcely an acre of woods in the south which cannot readily be reached by truck; in fact, the haul from most tracts to the nearest city or village is a matter only of an hour or two. Thus there is a much better opportunity to market forest products, particularly such low-quality items as fuel wood and fence posts.

Although there are numerous serious problems in taxation and local government in the southern Minnesota counties, these areas are not faced with the widespread tax delinquency and accompanying dislocations which make the outlook for forestry so uncertain in the north. Landownership is fairly stable, and there is no reason to expect any revolutionary changes in tenure.

Recreation and Water Conservation.

Upon the forest lands in the Hardwood and Prairie Districts rests a burden of use not only more intensive but also more varied than that in northeastern Minnesota. With denser population, there is greater need here for parks, campgrounds, game refuges, and public hunting areas. Water conservation is most essential in the prairie counties.

One area of special significance is the Red River marsh in the northern part of the Prairie District. Occupying the dried-out bed of glacial Lake Agassiz, this region was originally open marsh and brush prairie supporting scattered patches of spruce and aspen. In this condition the region was the natural home of waterfowl, prairie chickens, fur-bearing animals, and other game. Thief Lake, with a water area of 7,500 acres, was a typical wild-fowl retreat. About the time of the World War, enthusiasm for agricultural expansion led to the construction of drainage ditches throughout this territory and resulted in the removal of much of the surface water. Thief Lake and other water areas dried up completely.

Not only did the agricultural development fail to materialize, but it was soon found that drainage threatened to destroy other natural values

of the region. Fires spread over the marshes and ate into the timbered peat bogs. Game cover and food were reduced, and migratory birds shunned the mud beds. Farms were abandoned under the pressure of excessive drainage fees. Streams fed by the marshes became dry during the summer months

Recently, considerable interest has arisen in reclaiming these drained marshes for game production and water conservation. An area of nearly 20,000 acres, including the dry bed of Thief Lake, has been purchased by the State of Minnesota for a game refuge. At Mud Lake some 50,000 acres probably will be developed as a Federal wildlife refuge. Drainage ditches are being dammed and stranded settlers removed under some of the Federal emergency programs. Forests are being encouraged by improved fire protection.

Another important area from the standpoint of wildlife conservation is the Upper Mississippi River Wild Life and Fish Refuge, a strip of river bottomlands running south from Lake Pepin into Iowa and Illinois. This is a Federal refuge maintained by the United States Biological Survey primarily as a sanctuary for ducks, geese, and other waterfowl. About 25,000 acres of woodland is included in the Minnesota part of the refuge.

For concentrated recreational use, the State Conservation Department maintains some 15 timbered parks with an area of nearly 5,000 acres (4). During 1935 there were more than 75,000 visitors to these parks.

Very important, also, from the standpoints of recreation and of game production, are the thousands of isolated groves and hedgerows and the hundreds of lakes and ponds in private ownership scattered throughout the Hardwood and Prairie Districts. The lake region around Detroit Lakes and Alexandria draws tourists not only from Minnesota but from the Dakotas and other adjacent States as well. The Lake Minnetonka and White Bear regions close to the Twin Cities are, of course, intensively developed; while Lake Mille Lacs and points along the St. Croix and Mississippi Rivers are growing in popularity. Throughout this whole populous region no thoroughly satisfactory plan has been worked out for giving the public access to desirable camping and hunting areas without unjustly imposing upon landowners.

The Erosion Problem.

In the hilly country of southeastern Minnesota, pasturing and clearing of wooded benches and slopes have been followed by serious soil erosion. Not only are the denuded areas themselves affected, but adjoining tracts over which the water is permitted to flow are badly gullied or buried with silt. The soil thus washed from eroded hills creates a problem in highway maintenance and is a serious threat to the success of the 9-foot navigation channel now being constructed in the Mississippi.

Practically everyone concerned with the erosion problem in southern Minnesota agrees that the very steep slopes should be maintained in forest,

brush, or sod, and that even some of the benches and narrow ridges may have to be returned to woodland to prevent complete loss of the top soil.

But even such measures are inadequate in many places. Where terraces and narrow ridges are cultivated and water is permitted to concentrate and run directly down the slopes, even timbered areas will be gullied, and the gully lip will soon work back into the cultivated land. If the land is sufficiently valuable, the solution in these cases lies in engineering works and special cropping methods which will take care of the surplus water. With inferior land, however, the solution may be to return the entire area to forest or grass.

Shelterbelts.

Partly from the stimulation of the Timber Culture Act of 1873 and the Kincaid Amendment of 1911, and partly from an instinctive desire to have trees about the homestead, 7 out of every 10 settlers on the Minnesota prairies have set out plantations on their farms. Most of these plantations were established during the period of heavy settlement from 1880 to 1900. More recently, the activities of the State Extension Service have encouraged planting of additional shelterbelts in many localities.

Most of the earlier plantings were of rapid-growing but short-lived species such as boxelder and cottonwood. These are now passing maturity and are commencing to decay and die. The severe droughts of 1934 and 1936 have speeded their deterioration; even the younger and more hardy trees have succumbed during these extremely dry and hot seasons. Economic depression has added to the downfall of the plantations by inducing farmers to cut heavily for fuel and fence posts. The plantations on the whole are thus in bad shape (1).

Although the 1934 and 1936 droughts have been very destructive, certain species of trees, such as green ash and white elm, have withstood the heat and lack of moisture remarkably well. Since much has been learned about the selection of planting stock for different sites, and about methods of planting and cultivation, there need be no misgivings about the ability of good plantations to survive. Even in the much drier sections of the Dakotas, shelterbelts properly established and properly cared for have come through the drought in good shape.

There is no doubt that prairie farmers still desire plantations about their buildings and protective shelters for their stock, but under existing conditions it may be a long time before they are able to establish them.

Minnesota as a State, however, has never done much to aid shelterbelt planting in its prairie counties. It has not cooperated with the Federal Government in tree distribution, under the Clarke-McNary Act, as surrounding States are doing. With the renewed activity in farmstead planting which is manifesting itself in Wisconsin, the Dakotas, and other prairie States, it may be expected that Minnesota also will come to the aid of prairie farmers and help them with their planting problem.

The Need for Forests.

Conditions in the Hardwood and Prairie Districts of Minnesota indicate a need for a fairly large acreage of woodland, and suggest that intensive development of the better woodland areas would be justified. This is because the proximity of large markets to these districts insures a good demand for lumber, pulpwood, veneer stock, poles, posts, and even fuel wood -- a demand much better, in fact, than in the northeastern part of the State. There is, in addition, a strong and growing need for parks, campgrounds, and game refuges. It is also becoming recognized more and more that large areas of eroding cultivated land must be returned to forests or grass.

In contrast to these facts, statistics from the Forest Survey indicate that the acreage of woods and the volume of timber are small and still declining, and that the majority of farm woods are in such poor condition that they are yielding only a small fraction of their potential returns.

Forest History

Early settlers in southern and western Minnesota found about half of the land in forest and half in prairie. Most of the untimbered district, including the headwaters of the Minnesota and Red Rivers, consisted of tall-grass prairie (6)

Original Forests.

In the northwestern counties was a large, wet area in which open bogs and brush prairie intermingled with stands of spruce and tamarack. Along the river bottoms were stands of cottonwood, boxelder, green ash, silver maple, and elm. On the east the prairie was fringed with a savanna-like country supporting groves of aspen and scrubby bur oak intermingled with grassland. These prairie-border and bottomland forests originally occupied about one-quarter of the entire area of the Prairie District, but the standing volume of timber probably did not exceed 5 billion feet.

In the Hardwood District, most of the slopes and ridge tops were covered with timber. Stands were more dense and contained a greater variety of species than could be found farther west. Where the northern-hardwood region came in contact with the northern coniferous forest, there was a fairly broad transitional belt in which white-pine groves were generously scattered through the maple and red-oak woods. It was in these areas in Chisago, Isanti, Mille Lacs, Kanabec, and Pine Counties that some of the earliest pine logging in Minnesota was done.

Along the Mississippi from Little Falls to Hastings and spreading out through Sherburne and Anoka Counties was a stretch of sandy, glacial soils bearing scrubby timber -- the scrub-oak lands. A little farther south and occupying the heavier glacial soils west and south of the Twin Cities was the "Big Woods", a comparatively heavy forest of maple, basswood, elm, and red oak.

Along the slopes of the Mississippi below Hastings, and along the Cannon, Root, Zumbro, and other tributary streams, was yet another type of forest, characterized in the main by unglaciated, erodable soils and a timber mixture similar to the stands of Iowa and Illinois, usually referred to as the oak-hickory type. It was here that such species as walnut, butternut, honey locust, and coffee-tree invaded the State.

Of the entire area of the Hardwood District, about 80 percent was originally forested. This original stand totaled possibly 30 billion board feet.

Depletion.

The cutting of these forest resources began with the first white settlement in 1820 and continued at an ever increasing pace for half a century thereafter. Soldiers from Fort Snelling cut timber near the Rum River above Anoka in 1821. The first commercial mill, set up at Marine in 1839, cut logs from along the St. Croix and its tributaries. Later, mills at Stillwater, Minneapolis, Red Wing, Winona, and other river towns milled lumber from logs driven or rafted down these streams. Stillwater became the primary milling center on the St. Croix, and in its peak year, 1890, produced 452 million board feet of lumber. Meantime, the Mississippi, Rum, and Crow Wing River basins were yielding their pine to the mills at Minneapolis. By 1899 this city had a yearly output of 678 million feet and claimed to be the world's largest primary lumber market.

This heavy rate of cutting soon exhausted the accessible pine forests. As early as 1860 operations were pushing north into the coniferous forest region, and by 1875 the peak of pine logging in the hardwood region had passed.

The larger sawmills continued to operate for many years on logs brought in from the north, but eventually were obliged to close. The last big mill at Stillwater was abandoned in 1914, that at Minneapolis in 1921. Smaller mills, however, have continued to operate in the hardwoods, and it is believed that there are more mills today than 50 years ago. But the remaining sawmills are small, portable outfits, and volume production has definitely waned.

A century of exploitation and development has seen the mixed woods almost totally stripped of pine. The "Big Woods" has been culled over repeatedly, thinned by grazing and fire, and in many places totally cleared away. The scrub-oak stands have become even more sparse and scrubby, while the oak-hickory woods have been crowded back to the steepest and least fertile slopes. Only the bottomland forests retain any semblance of their original condition, and these are now beginning to lose out in the contest with agriculture and industry. Since settlement began, three-fourths of the timberland has been cleared and 95 percent of the saw-timber volume removed from the land.

Section 2. -- PRESENT FOREST CONDITIONS

Areas and Per-acre Volumes

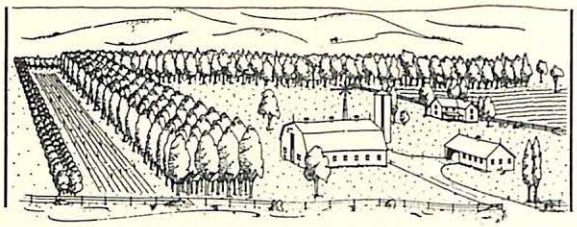
Of the 32,208,000 acres of land in the Hardwood and Prairie Districts of Minnesota, 4,161,500 acres, or 13 percent, is now natural woodland, and 86,300 acres, or one-quarter of 1 percent, consists of planted shelterbelts (tables I and II, appendix). Since seven-eighths of the total land area and four-fifths of the woodland are contained in farms, forestry is essentially a wood-lot proposition.

The bulk of the farm-woods area, however, is in very poor condition, as shown in table 1 below. A cross section of farms indicates that 85

Table 1. -- Prevalence of Different Types of Management in Wood Lots of the Hardwood and Prairie Districts of Minnesota

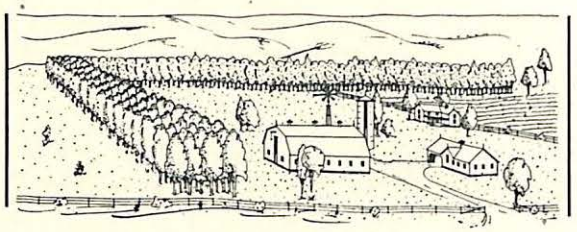
Type of wood lot	Percent of all wood lots		
	Both Districts	Hardwood District	Prairie District
Wood lots managed with a view to sustained yield and improved stand quality; presence of advance reproduction gives evidence of protection from grazing and fire	1	1	0
Well-stocked wood lots, reasonably well protected, but reserved rather than managed	13	12	16
Grazed wood lots with little or no advance reproduction; typically mature, with average stocking, and no promise for the future	40	37	54
Woodland pasture, the result of continued cutting and grazing; scattered trees of poor quality are all that remain	34	36	26
Land suited to wood production, but at present covered with brush; not being put to any use, even grazing	12	14	4
All types of wood lots	100	100	100

4 PERCENT
OF THE FARMS HAVE
MODEL SHELTERBELTS



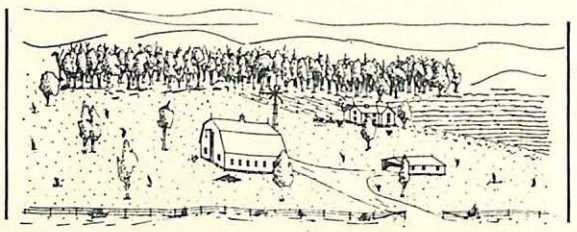
THESE FARMS HAVE THE BEST OF PROTECTION AGAINST BOTH WIND AND SNOW. MOST OF THE SHELTERBELTS WERE PLANTED SINCE 1925, AND HAVE BEEN PROTECTED FROM GRAZING.

24 PERCENT
OF THE FARMS HAVE
GOOD GROVES



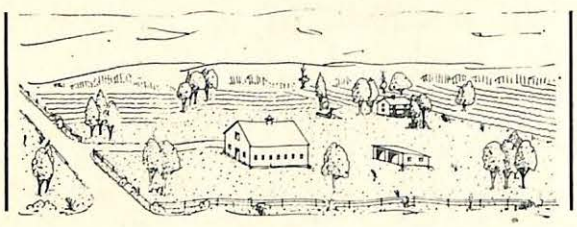
A GOOD GROWTH OF TREES – THOUGH OFTEN OF INFERIOR SPECIES. THE GROVES ARE TOO NEAR THE BUILDINGS IN MOST CASES; IN WINTER SNOW PILES UP IN THE FARMYARD.

40 PERCENT
OF THE FARMS ARE
POORLY PROTECTED



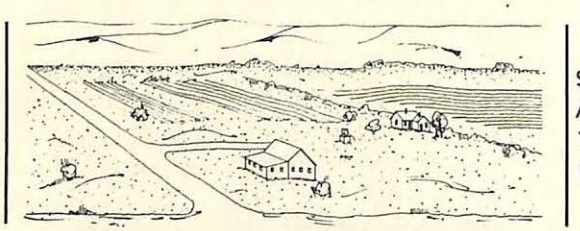
THESE SHELTERBELTS ARE TOO SMALL. MANY ARE DYING OF OLD AGE AND DROUGHT. CATTLE AND HOGS HAVE DONE THEIR SHARE OF THE DAMAGE.

18 PERCENT
OF THE FARMS HAVE
SCATTERED TREES



THERE ARE A FEW SCATTERED SHADE TREES IN THE FARMYARD, BUT PROTECTION AGAINST WIND AND SNOW IS AT A MINIMUM.

14 PERCENT
OF THE FARMS HAVE
NO PROTECTION



SUMMER AND WINTER THESE BUILDINGS ARE AT THE MERCY OF THE ELEMENTS. THERE IS NO PROTECTION – NOR A WISP OF SHADE.

Figure 1. -- Farm shelterbelt situation in the Prairie District of Minnesota, 1936, showing the preponderance of poorly protected farmsteads.

percent of the wood lots in the Hardwood District are pastured and 36 percent have been so heavily grazed that they retain only enough scattered, scrubby trees to qualify them as forest land. The planted shelterbelts of the Prairie District are in equally bad shape (see figure 1).

Statistics for the entire 4,161,500 acres of forest in the Hardwood and Prairie Districts bring out these significant points: (1) Two-thirds of the forest area is occupied by aspen, brush, grass, scrub oak, or scrubby swamp timber; only one-third, by valuable hardwood or softwood

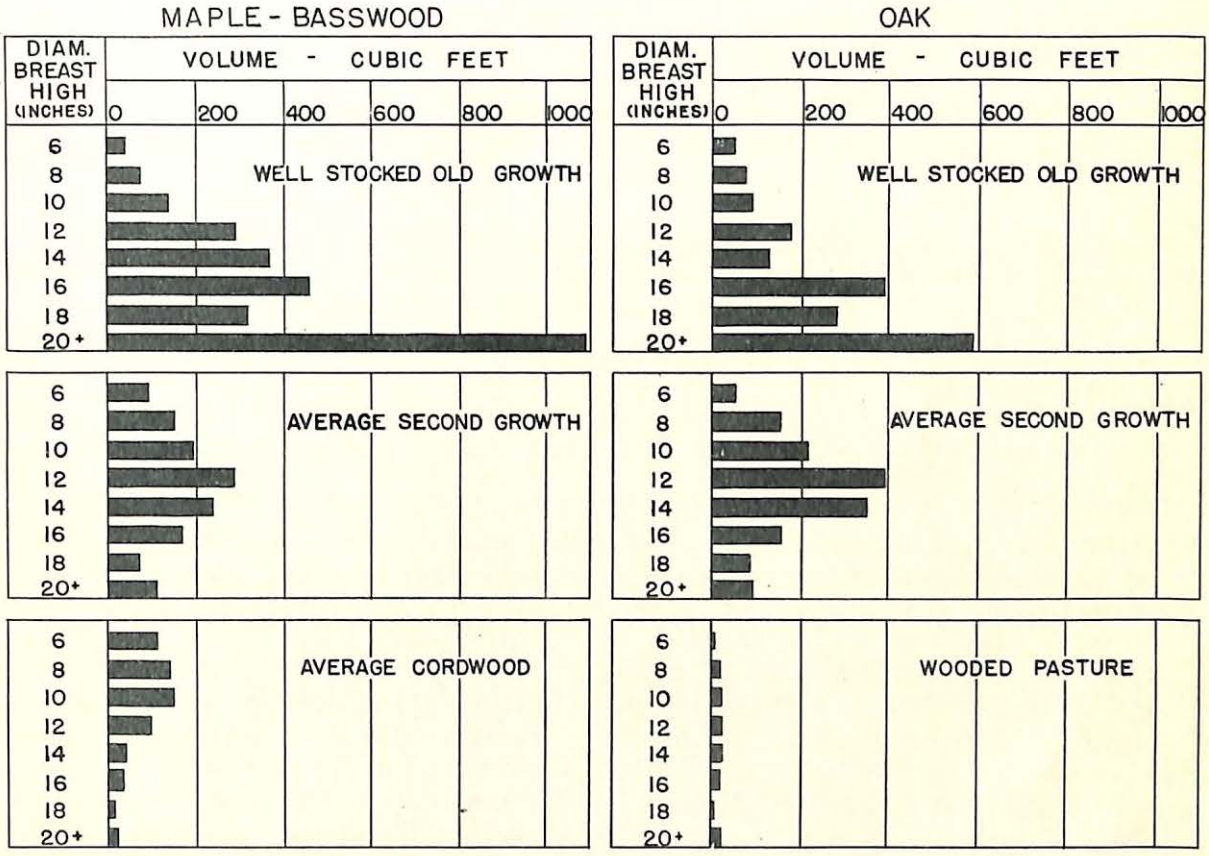


Figure 2. -- Distribution of cubic volume per acre, by diameter classes, in typical forest stands of Southern Minnesota

types. (2) Of the valuable types, only 349,200 acres, or 26 percent, is classified as saw timber. (3) Of the area of hardwood saw timber in the Hardwood District, only 5 percent bears as much as 10,000 board feet per acre, while 73 percent has a volume of only 2,000 to 5,000 feet per acre. (4) Poor stocking is also characteristic of cordwood and restocking land, due in large measure to grazing and fires. Of all cordwood land in the Hardwood District, 65 percent bears less than $7\frac{1}{2}$ cords per acre. Sixty-three percent of the land bearing reproduction is poorly stocked (less

than 40 percent of the area covered with seedlings). (5) In the understocked saw-timber stands there is a poor distribution of volume; that is, there is too large a share of volume in old, overmature trees, with insufficient small trees coming up to take their place (see table VIII, appendix).

The average volume per acre of saw-timber stands belonging to the oak type is 2,725 board feet of sawlogs (table IV, appendix), or about 19½ cords of total volume. For stands of maple-basswood the volumes average 3,589 board feet, or 21 cords. Cordwood stands of the more important types run about 10 cords to the acre. When it is considered that even such mediocre stands as these are to be found on only one-third of the forest-land area, and that the average stocking for this area as a whole is only 427 board feet of sawlogs, or 5 cords of total merchantable volume, per acre, some idea may be gained of the decadent condition of most timber stands in the Hardwood and Prairie Districts. These facts are elaborated in figure 2 preceding and in table 2 below.

Table 2. — Contrast Between the Original Forest and the Present Poorly Stocked Stands of Southern Minnesota

What prevailed originally	What prevails today
In Regard to Number of Trees on the Average Acre	
Utilization of available space was more or less complete.	Potential tree-producing capacity is only partially utilized.
With 353 trees per acre, the crown of each tree was confined to a space 11 feet square on the average, disregarding overlap.	Wooded pasture, representing worst conditions, has 53 trees per acre, or a space 29 feet square for each tree. Even average second-growth stands have only 240 trees per acre.
The product: Few limbs; high-grade lumber.	The product: Limby trees; low-grade lumber, or simply fuel wood.
In Regard to Distribution of Trees by Diameter Classes	
There was a good stocking of small-sized trees and a favorable representation of all sizes. The number of 2-inch trees made up 60 percent of the total.	Grazing and fires have greatly reduced the number of small trees; stands are not reproducing satisfactorily. The number of 2-inch trees makes up less than 20 percent of the total.
The outlook: New crops of wood from year to year.	The outlook: If present conditions continue, greatly diminished crops.

Table 2. -- Contrast Between the Original Forest and the Present Poorly Stocked Stands of Southern Minnesota -- Continued

What prevailed originally	What prevails today
In Regard to Distribution of Trees by Species	
Sugar maple, basswood, and good oaks predominated in the stand.	Sugar maple, basswood, and good oaks form but one-sixth of the stand on wooded pastures.
Aspen, paper birch, scrub oak, and cull trees accounted for only 2 percent of the total number of trees.	Aspen, paper birch, scrub oak, and cull trees account for 65 percent of the total number of trees.
The crop: Wood of desirable quality.	The crop: Wood of poorest quality.
In Regard to Volume of Wood on the Average Acre	
8,000 to 9,000 board feet of saw timber, 2,000 to 3,000 cubic feet, or	234 to 2,516 board feet of saw timber, 146 to 1,175 cubic feet, or
About 37 cords of wood.	From 2 to 17 cords of wood.
Significance: Even a small area of such timber could be made to produce a continuous supply of wood for farm needs.	Significance: A large area of such timber, at the best, would be needed for continuous production.
In Regard to Distribution of Volume by Diameter Classes	
Volume was concentrated in trees 16 inches or more in diameter breast high, with a gradual tapering off toward the smaller sizes.	Greatest volume centers around the 8-, 10-, and 12-inch diameters, with scanty representation of 16-inch or larger trees.
The cut: Potentially profitable, since mature trees of high quality may be removed, soon to be replaced from below.	The cut: Principally ties and posts; wasteful, since it removes immature trees not ready for harvesting.
In Regard to Distribution of Volume by Species	
Sugar maple, basswood, and good oaks made up more than three-fourths of the volume of saw timber and additional cordwood.	Sugar maple, basswood, and good oaks make up less than half of the volume of saw timber and hardly a quarter of the additional cordwood.
The yield: Largely the best species.	The yield: Largely inferior species.

Total Volumes

The volume of all living merchantable trees of saw-timber size on the 4 million acres of forest land in the Hardwood and Prairie Districts is 1,776 million board feet (table III, appendix), an average of 427 board feet per acre. There is an additional 1 million cords of pulpwood on the area, an average of 0.24 cord per acre. The total volume of wood in all trees 5 inches or larger in diameter breast high is 1,798 million cubic feet, or, roughly, 26 million cords, which means 6 cords per acre.

Nearly three-quarters of the total saw-timber volume, two-thirds of the cubic-foot volume, and one-third of the pulpwood volume are in the Hardwood District. Slightly more than two-thirds of the total board-foot volume is in stands having more than 2,000 board feet per acre (saw-timber stands). This volume is about evenly distributed between old-growth and second-growth stands (see table V, appendix).

In the Prairie District, softwood species account for relatively more saw-timber volume (table VI, appendix) -- 9 percent of the total. This volume of softwood originates mainly from scattered trees on cordwood, restocking, or deforested lands along the eastern border of this district in the northwest. Oak is the most important species from the standpoint of saw-timber volume, followed by elm, basswood, and sugar maple.

Five groups of species (table VII, appendix) account for the pulpwood volume in the two districts. Aspen alone makes up two-thirds of the pulpwood, spruce 16 percent, and tamarack 10 percent. Balsam and pine each contribute a small amount. Seventy percent of the pulpwood volume occurs in stands of cordwood size.

More than 81 percent of the total standing cubic-foot volume is in cordwood-size material -- small trees, tops and limbs of large trees, and cull (table III, appendix). Only 18.5 percent is in material merchantable for sawlogs. Volumes of principal species in the two districts are proportioned in table 3 below.

Table 3. -- Relative Volumes of the Principal Species of Trees in the Hardwood and Prairie Districts, Minnesota

Species	Percent of total cubic volume	Species	Percent of total cubic volume
Red oak	18	Paper birch	2
Aspen	14	Hickory, walnut, cherry	2
Elm	14	Red maple	2
Scrub oak	13	Tamarack	1
White oak	10	Black spruce	1
Basswood	9	All others	3
Sugar maple	6		
Ash, ironwood	5	All species	100

Depletion

The expected annual rate of depletion during the next 10 years is shown in tables XVII and XVIII, appendix. It amounts to 62,520,000 cubic feet, or approximately 333,000 cords. This is 4.5 percent of the total stand.

Of merchantable saw-timber material, about 73,390,000 board feet is expected to go for lumber or be lost from various causes. This is 4.1 percent of the total stand. Of trees smaller than sawlog size, 540,420 cords, or 5 percent of the standing volume, is the estimated annual depletion. About 71 percent of the average depletion is caused by cutting, 29 percent by fire and other enemies.

Table 4. -- Depletion, by Agencies, in the Hardwood and Prairie Districts

Agency	Percent of total depletion		
	Total cubic-foot volume	Sawlog trees	Cordwood trees
Cut for lumber, ties	17	44	-
Cut for fuel, posts	53	39	63
Cut for pulpwood	1	-	2
Total cut	71	83	65
Fire and other losses	29	17	35
Total depletion	100	100	100

Cutting.

Table 4 above shows that cutting for fuel and fence posts represents a remarkably large proportion of the depletion not only of cordwood-size material but also of saw-timber trees. It is usually the trees of poor quality which are cut for fuel wood, but there is also much valuable saw timber used in this way because the farmer is not aware of its value or is unable to market it properly.

Among the saw-timber operations, tie-cutting jobs are most common. During the past few years there has been a fair demand for railroad ties, and many small tie mills have been cutting in the Hardwood District. Pulpwood operators are relatively unimportant.

Fire.

Forest fires seldom sweep over large stretches of forest country in the Hardwood and Prairie Districts as they do in the northeastern forest

counties Yet, occasionally, severe fires do occur. The drained marshes in the northwest are very inflammable in dry seasons, and in years such as 1931 and 1934 are the means of spreading conflagrations into adjoining timberlands. Along the Mississippi bluffs, where no organized protection exists, fires start each spring from various causes and ordinarily are left to burn themselves out.

Each fire kills a few large trees, and on others leaves open scars where rot can enter, weakening some and leaving them exposed to the attacks of insects. Possibly the greatest loss, however, is caused by the destruction of the seedlings and small trees which should be forming the basis of a future stand.

Grazing.

The pasturing of cattle, sheep, hogs, and horses has probably contributed more than any other single factor to the degenerated condition of the wood lots in the district. Pasturing prevents normal reproduction. Even the hardy oaks cannot become reestablished when their seed has been consumed, their seedbeds trampled and packed, and their seedlings and sprouts heavily browsed. As will be seen in table IX, appendix, the typical wooded pasture consists of a few scattered and decadent old trees, with very few small trees coming up to take their place.

Insects and Diseases.

In the breeding of livestock the general plan is gradually to weed out the culls and thus strengthen the herd. Cows infected with tuberculosis or other communicable diseases are condemned and immediately removed. In the managing of wood lots, exactly the opposite plan has been followed in most cases: the best trees have been cut and the culls left standing. It is the diseased and infested tree which is most likely to remain in the woods. Little wonder that losses from insects and rot are high. There have been few epidemics of consequence in southern Minnesota -- merely a steady loss from year to year. With proper management, losses could be very materially reduced.

Drought.

The series of hot, dry seasons commencing in 1930 has taken a heavy toll of both planted and natural timber in the Hardwood and Prairie Districts (2). Among the plantations, cottonwood, boxelder, and other rapidly growing species were hard hit; green ash and some of the elms stood up much better. In natural woods, red oak, which has a characteristically shallow root system, suffered severely. Some trees which were weakened during the dry weather of 1934 have been killed subsequently by insects.

Winds.

Minnesota lies north of the main tornado belt, but "twisters" occasionally pass over the Hardwood District, tipping over and breaking strips

of mature timber. Most of this material is salvaged for fuel wood, but a certain amount of saw timber is unavoidably lost.

Land Clearing.

Most of the timber cut in connection with land clearing is utilized in one way or another. In out-of-the-way places, however, some material thus cut is merely piled and burned. The tendency now is to clear more and more of the level timbered areas, letting some of the rougher and worn-out tracts cleared in former years revert to brush and reproduction.

Depletion per Acre.

Although depletion is high in comparison with standing volume, in absolute amount it is low. The annual drain amounts to about 18 board feet of saw timber per acre of forest land plus 0.13 cord of smaller material. Under good management, this area of forest should be capable of supporting permanently a cut several times this size.

Growth

At the same time that cutting, fire, and other agencies are reducing the volume of living timber, this same timber is putting on growth, which tends to offset the depletion. The annual growth of merchantable saw-timber material estimated for the next 10 years is 64,380,000 board feet for the Hardwood and Prairie Districts combined, or 3.6 percent of the standing volume. The growth in total merchantable volume is estimated to be 58,450,000 cubic feet, or 4.2 percent per year; the growth in pulpwood, 58,000 cords, or 5.8 percent (see tables XIX and XX, appendix).

Growth rates in the Hardwood District are in general higher than those in the Prairie District, both because of better growing conditions and because of the larger growing stock per acre. The average growth of sawlog material in all cover types and condition classes is 19 board feet per acre per year in the Hardwood District, 11 board feet in the Prairie District. The average growth in total volume is 17 and 10 cubic feet per acre per year in the two districts respectively.

Of the principal cover types the fastest-growing, from the standpoint of total volume, is the oak, with a rate of 30 cubic feet, or about four-tenths of a cord, per acre per year. This gives a total growth of 12.9 million cubic feet for the entire type in the Hardwood and Prairie Districts. The maple-basswood type, while slightly slower growing, has enough additional area to equal the total growth of the oak type. The aspen-birch cover type, normally fast growing, is so largely represented by stands in the restocking condition class that its average growth is relatively low -- 22 cubic feet per acre per year. Its large area, however, gives it a total growth slightly greater than that of the oak type.

Together these three types account for two-thirds of the total growth in cubic volume in the two districts. In the Prairie District the

bottomland-hardwood, deforested, and scrub-oak types contribute most of the remainder, while in the Hardwood District the tamarack-swamp type also is important.

In respect to saw-timber volume, the fastest-growing hardwood cover type is the bottomland hardwoods, which are putting on an average of 46 board feet per acre per year in the two districts. The oak type is growing at the rate of 41 board feet per acre per year, and maple-basswood, 34 board feet. The growth in these three types is 70 percent of the total board-foot growth in the Hardwood and Prairie Districts. The aspen-birch, deforested, and scrub-oak cover types account for most of the remainder.

Nearly half the growth of pulpwood takes place in the aspen-birch cover type. The scattered stands of black spruce in the northeastern part of the Prairie District contribute a small additional amount.

Of the total growth in each kind of product, more than half is expected to be put on by trees which are now smaller than merchantable size: during the next 10 years their diameter will increase to the point where they will acquire volume according to the standards of the Forest Survey. Thus the major share of the growth in pulpwood and total cubic-foot volumes will be contributed by trees now less than 5 inches in diameter, and most of the board-foot growth will come from trees with present diameters of 6 to 9 inches. This is a significant side light upon the growth estimates, for it indicates that most of the additional volume coming into the average stand from year to year will be in the very smallest-sized, and therefore least valuable, trees.

The way in which the total board-foot and cubic-foot growth is distributed among the various condition classes is shown in table 5 below.

Table 5. -- Distribution of Growth by Condition Classes

District	Unit of measure	Percent of total growth			
		In saw-timber stands	In cordwood stands	On restocking or deforested areas	Total
Both	Bd. ft.	42	44	14	100
	Cu. ft.	20	54	26	100
Hardwood	Bd. ft.	45	41	14	100
	Cu. ft.	22	53	25	100
Prairie	Bd. ft.	34	51	15	100
	Cu. ft.	15	55	30	100

Growth Versus Depletion

To what extent does this growth offset the depletion from cutting, fire, and other causes? Table XXI, appendix, shows the comparison between growth and depletion of each of the three kinds of products -- saw timber, pulpwood, and total volume -- by cover types. From this table it would appear that growth falls 12 percent short of the depletion of saw-timber material and exceeds depletion of pulpwood by 93 percent; and that for the total volume of all products growth makes up 93 percent of the depletion; so that there is a net reduction of the growing stock amounting to 4 million cubic feet each year, or a little more than one-quarter of 1 percent of the growing stock itself.

While this does not appear to be a particularly serious state of affairs, there are several additional factors involved which combine to make the growth-depletion relationship in actuality unfavorable:

1. Growth occurs mainly in the smallest-sized material, while depletion is chiefly in the larger sizes: although much new wood is being produced, little of it is of a size suitable for cutting. If depletion continues at the predicted rate, it will not result immediately in decreasing greatly the total volume of standing timber, but it will result in creating a preponderance of small-sized stands which will yield little but fuel and small posts for many years.

2. A considerable share of the growth is on low-grade trees; the burden of the cutting falls on the better grades. The result is an increasing proportion of the poorer grades.

3. Much of the growth is on scattered trees and in inaccessible stands. On the other hand, depletion is concentrated in accessible and well-stocked stands. Volume is being added to many trees which cannot be cut economically.

4. Because inferior species predominate in total volume, they predominate also in respect to growth. However, the cutting of good species exceeds the cutting of inferior ones, the result being a steady increase in the proportion of inferior species.

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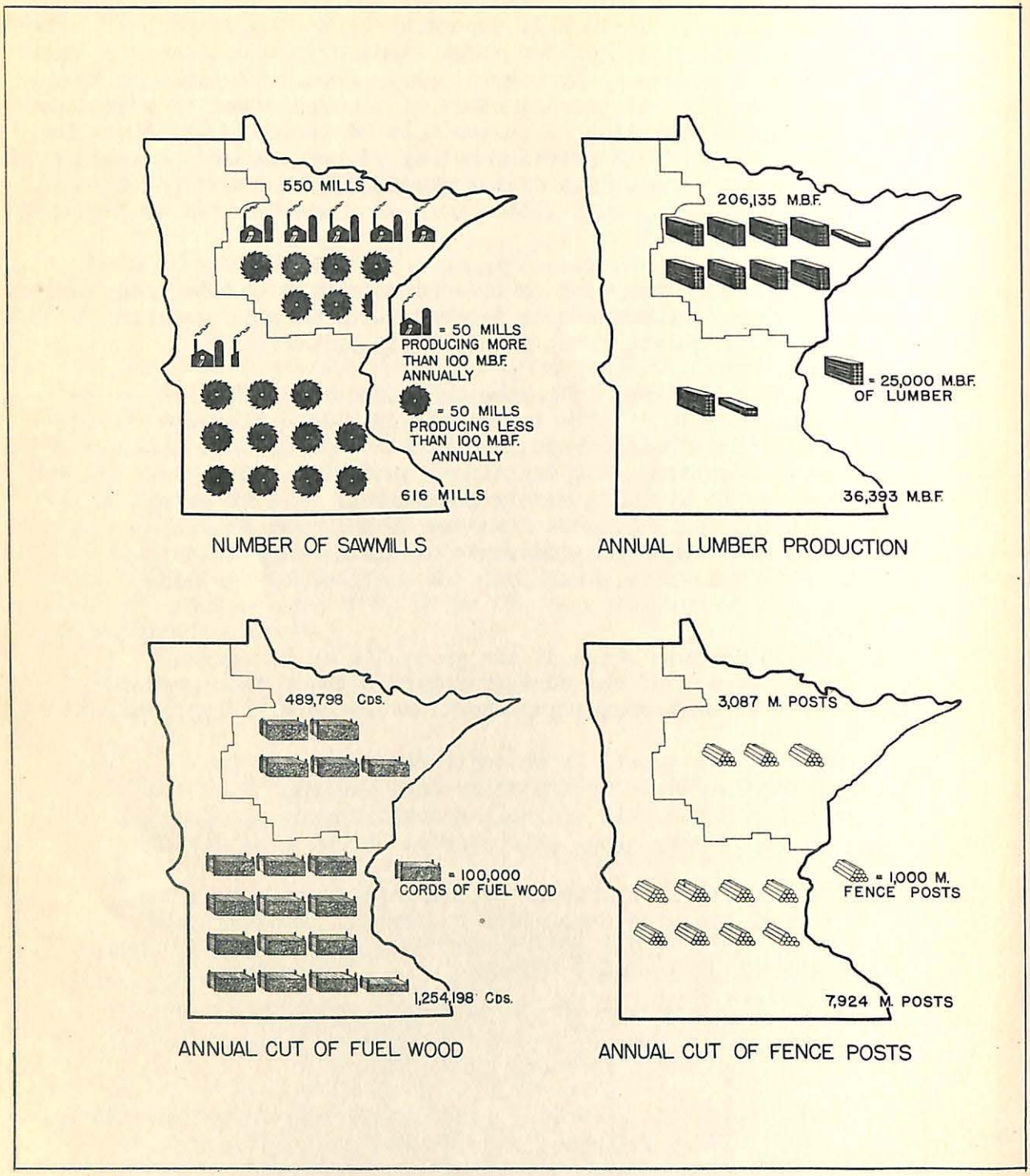
550 MILLS
= 50 MILLS PRODUCING MORE THAN 100 M.B.F. ANNUALLY
= 50 MILLS PRODUCING LESS THAN 100 M.B.F. ANNUALLY
616 MILLS
NUMBER OF SAWMILLS
206,135 M.B.F.
= 25,000 M.B.F. OF LUMBER
36,393 M.B.F.
ANNUAL LUMBER PRODUCTION
489,798 Cds.
= 100,000 CORDS OF FUEL WOOD
1,254,198 Cds.
ANNUAL CUT OF FUEL WOOD
3,087 M. POSTS
= 1,000 M. FENCE POSTS
7,924 M. POSTS
ANNUAL CUT OF FENCE POSTS

Figure 3. -- Comparison between southern and northern Minnesota sawmills and forest products.

Section 3. -- WOOD REQUIREMENTS AND FOREST UTILIZATION

Putting aside for the moment many supplementary uses of forests and forest land, the basic contribution which forests make to economic life is the wood produced. Even in this age of metals, cement, coal, and oil, wood remains an essential raw material. In southern Minnesota, and to no less extent in the western part of the State, forests have contributed to past industrial and agricultural development. Cutting, milling, and marketing of wood have provided a livelihood for a large number of persons, while cheap lumber and other products have made possible rapid rural and urban development.

With the virtual exhaustion of commercial timber supplies in southern Minnesota and adjacent northern counties, the wood-using industries that remain are obliged to import most of their raw materials at high freight rates from the Pacific Coast States and the South. In competitive markets local industries are thus at a disadvantage, and will face further decline until more abundant local wood supplies can be provided.

The farm woodlands of southern Minnesota can be so managed as to produce a larger share of the needs for wood on farms, and in some cases can be made to supplement farm income through sale of fuel wood, posts, ties, and rough lumber. A review of the facts shows that local farm woods, even at present, are a vital factor in agricultural if not in industrial economy. Figure 3 and tables XII to XVI, appendix, indicate that the Hardwood and Prairie Districts produce a substantial quantity of wood. Looking into the future, the time may come in parts of southern Minnesota when small wood-using industries and markets adapted to the timber that can be grown will provide a steady and substantial source of farm income.

Industrial Requirements

The principal wood products required by the industries of the Hardwood and Prairie Districts are lumber, railroad cross ties, and paper pulp. A few veneer, cooperage, shingle, and other mills create an additional demand for wood. On the whole, only a small fraction of the requirements of the industries can be supplied by local plants.

Lumber.

The probable annual lumber requirements in the Hardwood and Prairie Districts for the immediate future are estimated to be in excess of 450 million board feet: 300 million for construction and more than 150 million for manufacture and industrial use.

Estimates of requirements for urban construction are based upon the gradual increase in population and upon the present normal rate of replace-

ments, repairs, and new construction. For the immediate future the number of farms is assumed to be reasonably stationary, with annual requirements of nearly 1,000 board feet of lumber per farm for repairs and additions to buildings.

The prediction of future industrial requirements for lumber, veneer, and wood in other forms is based on the recent past and not on prospective markets for woodland timber which may be developed in the future. The more important products made of wood in southern and western Minnesota are boxes and crates, furniture and fixtures, refrigerators, and other goods of these types. Sash, frames, doors, blinds, and all planing-mill products are of importance, but are omitted from the total of manufacturing industries to obviate duplication of figures for construction requirements.

Requirements for both construction and manufacture are such that they cannot be completely supplied from Minnesota forests. Construction lumber is predominantly and preferably softwood; for this supply the Hardwood and Prairie Districts must look to northeastern Minnesota and other regions. Local woodlands can supply some oak, maple, cottonwood, elm, and other hardwoods for rough building on farms, but only long-term management for quality saw timber and careful manufacture will produce much good flooring and other more valuable products from local oak and maple.

Manufacturing industries require comparatively high-grade lumber and veneer logs for their better products, as well as low-grade material for boxes and crates. Few of the high-quality wood requirements are at present met by local supplies, even pine, oak, maple, and other species common to Minnesota being imported from other States. Present rough-wood requirements are only partially filled by cottonwood, aspen, and other softwoods of inferior quality.

But looking into the distant future, as one interested in forestry must, it appears that there are few major requirements which cannot be supplied by the forests of the State. The oak, maple, basswood, and other hardwoods which can be grown in southern Minnesota should be able to fill more of the requirements for products made of these woods than they now do.

The sawmill situation. -- Turning to the present, one finds that slightly more than half -- 616 -- of the 1,166 sawmills in Minnesota are located in the southern and western parts of the State. However, as figure 3 shows, these are all rather small mills. Their average annual production amounts only to 15 percent of the State production of lumber and sawed ties and fills only about 8 percent of the lumber requirements of the Hardwood and Prairie Districts (see tables X and XI, appendix).

Most of the mills are small, portable outfits owned either by farmers or by small operators who move from place to place doing custom or contract sawing. A few are operated in connection with lumberyards, or by operators who purchase and log small tracts of timber. These facts, however, should not belittle the importance of these mills as a means of marketing woodland timber. Sawmills of this type are adapted to the

marketing of such timber as is now available in farm woods, and they do supply considerable seasonal employment.

Increasing the production and quality of timber by careful management will make possible more stable and better-equipped sawmills and, doubtless, will encourage establishment of other wood-using industries. Proper sawing, seasoning, and grading of lumber will do much toward providing a better market for woodland timber.

Railroad Cross Ties.

Production of railroad ties in southern Minnesota is for the most part a typical example of short-sighted use of farm woods. Recent economic conditions and a ready market for ties have brought liquidation of considerable hardwood timber at the relatively low rate of return which ties bring.

Present annual production of ties from local timber in the Hardwood and Prairie Districts is about 147,000 ties, largely sawed in portable mills. This is only one-seventh of the requirements of railroads in this part of the State. It would be a mistake to look toward self-sufficiency in the immediate future as an objective for tie production. Cutting for ties should be only from inferior timber which cannot produce the higher grades of lumber. Certainly the smaller saw-timber trees which are growing at a maximum rate should not be cut for ties.

Pulp and Paper.

The present national average of paper and paperboard consumption is about 200 pounds per capita (9). This average applied to the population of the Hardwood and Prairie Districts indicates a total annual requirement of 220,000 tons of paper, which is equivalent to about an equal number of cords of wood.

During the last few years the amount of wood converted each year by the two pulp mills in the Hardwood District, at Sartell and Little Falls 1/ on the upper Mississippi River, has been less than 20,000 cords, hardly one-tenth of the amount needed to meet local requirements. There are two paper mills in the Twin Cities which use straw, wastepaper, and imported wood pulp as raw materials. But quite evidently southern and western Minnesota cannot look forward to self-sufficiency in pulp and paper.

The problem, then, is that of supplying existing pulp mills with necessary wood. Being equipped to handle ground wood, chiefly spruce, the two pulp mills in recent years have been able to obtain only about 2,000 cords annually from adjacent forests. The remainder of their requirements has come chiefly from northern Minnesota.

Although there are supplies of spruce pulpwood available along the northeastern margin of the Prairie District, these are less accessible to

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1/ The mill at Little Falls has not been in operation recently.

Sartell and Little Falls than is the spruce in the Central Pine and Cloquet Districts. Previous reports on these adjacent districts[2] have shown that the demand for spruce pulpwood is in excess of growth. The ultimate solution of the problem of pulpwood supplies for the mills in southern Minnesota, if they are to continue in business, may be an adjustment in pulping methods and products to utilize the abundant supplies of aspen and jack pine found bordering the Hardwood District on the north.

Other Wood-using Industries.

In addition to the 616 sawmills and 2 pulp mills, there are in the Hardwood and Prairie Districts a few other establishments which draw on the forests of Minnesota for raw materials in the form of logs or cordwood. The mills contacted in connection with the Forest Survey included, in the Twin Cities area, one excelsior plant, two cooperage plants, and one veneer box factory. To the north and west are three plants producing veneer used in boxes and crates, three lath mills, and two shingle mills. Along the northeast border of the Prairie District are two veneer box and crate factories. This list does not include box factories which obtain their lumber from sawmills.

Except for shingle mills, which require cedar, these miscellaneous plants can all subsist on local, second-growth hardwood timber, chiefly aspen, cottonwood, and basswood. In fact, it is these types of industries which in the long run through better utilization may aid in establishing good markets for the type of timber which can be grown in farm woods.

Forest Utilization

Although the forests of the Hardwood and Prairie Districts are able to furnish only a small portion of industrial requirements for wood, they play a very important role in supplying certain farm and local needs, particularly for fence posts and fuel wood. As figure 3 shows, the annual cut of these products in the two districts constitutes by far the greater proportion of the yield in the whole State.

Posts.

A sampling study of fence posts, made in connection with the Forest Survey, showed that there were approximately 112 million posts in use in the Hardwood and Prairie Districts in 1935 -- an average of 715 posts per farm. Of these, about 7 percent were steel or concrete. Based upon the average life of the various kinds of posts found in use, average annual replacements were estimated to be over 8 million posts, or 54 posts per farm.

In the Hardwood District most of the required posts were obtained from local sources, only a few steel and cedar posts being imported. In

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[2] See footnote 1, page 3.

the Prairie District local supplies were being augmented by shipments from other parts of Minnesota.

During the past few years many fences have been allowed to fall into a state of disrepair or have been renewed with inferior posts. Consequently, if fences are to be put in good condition during the next decade, annual replacements may be abnormally high. For normal conditions, annual production of wood posts for local needs has been computed as in table 6 below.

Table 6. -- Annual Production of Wood Posts in the Hardwood and Prairie Districts of Minnesota

Species	Number of posts	Percent of total
Oak	6,414,754	81.0
Conifers except cedar	653,113	8.2
Cedar 1/	26,010	0.3
Inferior hardwoods	569,768	7.2
Better hardwoods	260,777	3.3
All species	7,924,422	100.0

1/ Cedar posts make up 8 percent of the posts in use, but comparatively few are produced in the Hardwood and Prairie Districts.

By planning for future needs, the farmer could avoid any cash outlay for fence posts. Even in nonforested areas, posts can be grown in shelterbelts and can be treated with creosote if they are not of durable species. Many kinds of wood posts now in use are hardly worth cutting and setting unless given some sort of preservative treatment.

In most farm woods, cutting of posts need not be a drain on sawtimber supplies, but may be a salvage cutting from cull and dead trees, tops of trees cut for sawlogs, or from overly dense pole stands. At present, however, too many posts are cut from trees which now or in the near future could be marketed for lumber or other more valuable products.

The use of posts along highways and for other nonagricultural purposes in the Hardwood and Prairie Districts provides a good market for cedar posts from northeastern Minnesota, although even for these uses local posts, properly treated, could partially fill the requirements.

Fuel Wood.

A cross-section survey of farms in the Hardwood and Prairie Districts reveals that about 7 cords of wood are burned each year on the average farm.

Together with sales, annual cut of fuel wood probably exceeds 1¼ million cords at the present time. This is about 50 percent more than the volume of production reported to the U. S. Census in 1930 (7). The census figures, no doubt, were not quite complete. Also, during the last decade of declining agricultural prices, many farmers have found it necessary to make greater use of wood as a fuel or to supplement their income by sale of wood.

There are few farms which do not use some fuel wood, but wood does not fill all farm fuel requirements. In southeastern Minnesota 37 percent of the farms visited used some coal, 15 percent used some oil, and 16 percent used corncobs as fuel. In the western part of the State, where farm woods are often lacking, 63 percent of the farms used some coal, 8 percent some oil, and 50 percent made use of cobs to a greater or less extent.

Use of wood for fuel is directly related to availability, although even in wooded southeastern Minnesota 16 percent of the farms visited were found to be buying wood or stumpage for fuel. In this area most farmers are able to obtain sufficient wood from their own or adjacent woodland, and use of coal is largely a matter of convenience. In the western, prairie counties of Minnesota, on the other hand, coal and other fuels must be resorted to on most farms, since wood is not available. Only 10 percent of the farms there were found to be purchasing wood or stumpage for fuel. Some wood is brought in from adjacent forested districts, but bulk and distance prohibit long shipments for farm consumption.

About two-thirds of the fuel wood cut in 1934 was obtained from cull trees, dead and down material, or small, suppressed trees which would probably die or at least would never produce valuable timber. Selective cuttings of this kind are distinctly beneficial to the woodlands, inasmuch as they improve the growing conditions for the better trees.

On the other hand, 12 percent of the fuel wood was cut from merchantable sawlog material, and 22 percent came from small, sound cordwood trees which if left would someday produce saw timber. Cutting of these more valuable trees occurs mainly where land is being cut clean. In southeastern Minnesota 26 percent of the fuel wood obtained in 1934 was from clear-cutting operations, and in the western district 18 percent was so obtained. This fact in itself indicates that woodland acreage is being steadily reduced.

Other Forest Products.

Other forest products worthy of mention which are produced from local forests or are required in the Hardwood and Prairie Districts include piling, cabin logs, and poles.

Oak piling needed for Mississippi River improvements and for highway work throughout southern and western Minnesota is supplied by local woodlands of better quality. Pine and tamarack piling are obtained from central and northern Minnesota.

Cabin logs or poles, if available locally, are finding considerable use in roadside and camp construction. However, the softwoods commonly used -- Norway and jack pines, spruce, and balsam -- are scarce in the Hardwood and Prairie Districts. Some of this material is trucked or shipped from the north.

Although at one time the swamps of northern Minnesota produced a great many cedar poles, supplies are now depleted and will only be renewed over a period of years. Present production in the State is not large enough to meet the requirements of the Hardwood and Prairie Districts. Scanty local pole supplies are used only for rural telephone lines. Larger poles for telephone, telegraph, and power lines must come chiefly from other States.

Section 4. -- MEASURES TO IMPROVE THE SITUATION

Causes of Poor Forest Management

A review of the forest situation in the Hardwood and Prairie Districts of Minnesota reveals a greatly reduced forest area, a deteriorated growing stock increasingly dominated by inferior trees, and an annual depletion exceeding growth and yet falling far short of meeting the industrial and domestic requirements of the section.

This poor condition of forests in southern and western Minnesota can be traced to three things: (1) Lack of general understanding of the technique of forest management; (2) economic conditions unfavorable to wood-lot maintenance, including particularly the growth of the dairy industry; and (3) an attitude of indifference on the part of the public toward the problems of the region.

Forest-management Technique.

Cutting operations in farm woods largely have failed to take advantage of the fact that trees are a growing and renewable resource. Following the practice of early settlers, many farmers even today cut clean each year that part of their wood lot which lies nearest at hand. By this practice the possibility of further yield from the tract is postponed for 60 or 80 years. Again, the practice may be to select for removal only certain trees within the stand, but almost invariably the trees selected are the straight, thrifty specimens which are growing rapidly in size and quality. The overmature, crooked, and defective trees are left in possession of the ground.

Cutting methods. -- In general, the hardwood forests of southern Minnesota lend themselves well to some form of selective cutting. Under a proper selective-logging system, only the mature and overmature trees are cut, including, of course, the suppressed and deformed trees, which cannot be expected to survive to maturity. If the stand is in good shape to begin with, the cut can, with propriety, be made equal to the rate of growth; if it is in a depleted condition, a lighter cut would be advisable for a period of years.

In the uncut hardwood forest, thrifty trees of such species as maple, basswood, red oak, and elm will grow at least $1\frac{1}{2}$ inches in diameter in 10 years. When the trees are released by thinning or selective logging, their growth will be nearer 2 inches in 10 years. This means that an 8-inch tree will become 10 inches, a 10-inch tree 12 inches, and so on, during a single decade. Trees larger than 16 inches in diameter, however, usually begin to slow down, and eventually the largest trees stagnate in growth.

The 8-inch tree has no board-foot volume, but in 10 years it should contain on the average 22 board feet of sawlog material. The 10-inch tree in becoming a 12-inch will add 32 board feet: it will more than double its

merchantable volume in 10 years. A 12-inch tree will add 45 board feet, a 14-inch tree 57 feet, and a 16-inch tree 66 feet, while increasing its diameter 2 inches.

Studies have borne out the fact that the volume being added to large trees, say 16 inches or more, is of better quality than that added to smaller trees (10). Thus, volume, quality, and value increase by leaps and bounds with increasing tree diameter, which is testimony to the fact that small trees should not be cut but should be left to realize their potential growth.

Cultural measures. -- An ordinary well-stocked maple-basswood wood lot in southern Minnesota should grow about 150 board feet per acre per year. Without care, about one-third of this will be lost through windfall, crowding, and decadence; but by periodic thinning and salvaging of overmature and damaged trees, the owner can realize practically the full rate of growth.

In the younger stands of hardwoods not yet ready for commercial logging, much good could often be done by thinning the too-dense thickets and weeding out the undesirable species. This would tend to accelerate growth, improve the composition, and incidentally provide a few cords of firewood.

In older stands, likewise, improvement cuttings are often needed to remove decadent wolf trees which retard development of the stand. Such cuttings may be profitable (although probably not on a commercial scale) even though no products of real value are obtained in the process. Operations of this kind can be accomplished piecemeal by the farmer in connection with obtaining fuel wood or as a slack-time occupation in winter months.

Planting. -- Most hardwood lands will restock naturally if protected from fire and grazing. Pastured areas where there is a heavy sod, however, may remain poorly stocked for years, even after being fenced. Some other abused areas are inclined to come into aspen, paper birch, ironwood, and other more or less undesirable species.

To overcome these handicaps and speed up regeneration, planting is sometimes resorted to. Successful planting requires selection of the proper species for the site, choice of good planting stock adapted to the region, use of correct planting methods, and some subsequent care until the plantation becomes well established. Planting in shelterbelts involves the same sort of problem, and requires even more skill and more sustained care.

It is true that proper forest management in a region bordering the prairie involves technical difficulties with which farmers too often are not prepared to cope.

Economic Conditions.

There is somewhat more than 2 million acres of farm woods in the Hardwood District distributed among 70,200 farms -- an average of 30 acres

of woods per farm. The average wood lot contains 17,400 board feet of merchantable saw timber and 197 additional cords of small trees, tops, limbs, and cull -- 600 board feet plus 7 cords per acre. Current growth amounts to 19 board feet plus $\frac{1}{4}$ cord per acre per year, or 570 board feet and $7\frac{1}{2}$ additional cords per wood lot.1/

Under the present methods of utilization, with about 45 percent of the sawlog volume going for fuel wood and most of the balance for tie timber, the average return for stumpage is only about $4 per thousand board feet plus 50 cents per cord. Annual growth in terms of value, then, is about $6.03 per wood lot, or 20 cents per acre annually.

Taxes. -- Current taxes on rural land in southern Minnesota average about 82 cents per acre. Although assessors in evaluating farm land place

Table 7. -- Average Full and True Valuation per Acre, by Classes of Land, on 13 Sample Farms Near Hokah, Minnesota

Class of land	Full and true valuation per acre	
	Dollars	Percent of the average of all classes
Cultivated	33	236
Meadow	14	100
Pasture	8	57
Cut-over	6	43
Timber	5	36
Waste	3	21
Average of all classes	14	100

a relatively low valuation upon timbered areas, yet on the tax statement all classes of land on a farm are grouped into a single unit, with an average tax for the whole area. This system, with its apparently high tax on farm woodland, presents a grave psychological obstacle to proper management. The average farmer feels under pressure to utilize each parcel of his farm as intensively as possible, and hence is more than ever inclined to pasture his wood lot.

In table 7 above are presented sample figures of "full and true" valuation for tax purposes, separated by classes of land. These figures were compiled from the assessors' records of 13 farms located in a half township near Hokah, Houston County, Minnesota.

1/ This is gross growth, including the volume of trees expected to die.

Marketing. -- One of the causes of low annual yield from wood lots is the fact that the farmer has very poor facilities for marketing his products (5). With only a handful of logs to sell, he cannot afford to sort them and seek out the logical buyer for each particular variety. Usually he sells the lot to a tie merchant at 10 to 20 cents per cut. Not infrequently, walnut and good No. 1 logs of other species are included in flat-rate sales to tie jobbers without any substantial adjustment of price. Poor marketing facilities even lead to the use of sawlogs for posts, fuel wood, and other products for which poorer material would serve. Most farmers do not recognize the wide spread in value between tie cuts and high-grade logs, or, if they do, they are unable to take advantage of it, through lack of suitable marketing facilities. Tie timber is worth about $4 per thousand board feet, No. 2 logs about $15, veneer bolts from $20 to $35 depending on species, size, and quality.

Pasturing as a competitive use. -- The Hardwood and Prairie Districts are primarily a dairy-farming region, and there is always a demand for pasture. At present 87 percent of all farm woods are pastured. What is the relative value of land for timber and for pasture?

Evaluation of the forage crop is, of course, uncertain, for there is little reliable data on the number of animals which can be supported on different types of land. Lightly stocked woods on gentle slopes of good soil might support a cow for a season on every 2 acres of area, while steep, rough land or dense woods have little forage value. If 5 acres of the average pastured wood lot will support one cow for 3½ months, the income represented (using a forage rental value of $1 per head per month) is 70 cents per acre per year. Adding to this the income of 20 cents per acre per year from growth of wood products, total annual income from an average acre of pastured woods is found to be 90 cents. It is true that most wood lots have certain intangible values in addition to those derived from forage and wood production, but such values seldom result in an actual money income and may be disregarded in this calculation.

It is generally agreed that pasturing is undesirable on steep slopes, particularly in the unglaciated region along the lower Mississippi. Not only is there little forage available, but the trampling and thinning of underbrush lead to soil washing and erosion. Yet even here economic factors tend to force the more intensive use.

While the average farm unit in southern Minnesota is nearly 160 acres, there are numerous farms of 80 acres or less, some on rather poor soil. Although it might seem desirable to maintain a portion of such farms in unpastured woods, a farmer on one of these small units must crowd it to the utmost to support a herd large enough to maintain his family, even though the farm be ruined in the process. Thus, one of the obstacles to farm forestry as well as to erosion control is the uneconomic size of the farm unit.

Tenancy. -- A final factor operating against proper forest management in southern and western Minnesota is the high degree of tenancy. According to the census statistics (7), about 37 percent of the farms are

operated by tenants or part owners. Naturally, tenants do not take the same interest in maintaining the productivity of woodland that the owner would take. They are more inclined to squeeze out the immediate returns rather than look to the ultimate yield. This factor is a serious obstacle to establishment of shelterbelts in western counties.

Public Attitude.

It is only within the past 2 or 3 years that the value of Minnesota farm woods in the general State economy has been given recognition. Only very recently has any effort been made to control fires running over the timbered slopes of southern Minnesota. The problem of soil erosion has been considered only for 4 or 5 years. In extension work the entire load has fallen on the shoulders of one extension specialist working out of St. Paul. The field of forest research in farm-woods territory has been largely neglected. In short, there has been little encouragement or stimulation of any kind offered to forest-land owners in the farming region.

During the past few years public aid has been offered in several localities, and the response has been encouraging. Some 8 or 10 C.C.C. camps have been operating for 4 years in the extreme southern end of the Hardwood District. The objective has been erosion control, but a large and increasing share of the daily work has been the reestablishment of forest cover on denuded slopes. The State Conservation Department has inaugurated a fire-protection system to prevent spring and summer fires in the southern part of the State, and it expects a reduction in losses from such fires.

The soil-conservation program set up to replace the A.A.A. is offering benefit payments to farmers who replace soil-depleting crops with planted forests, and maintenance payments are made on natural woodlands fenced and protected from fire. State relief agencies are attempting to help prairie farmers to replace shelterbelts destroyed by the drought.

The need now is to replace these temporary, emergency measures with a well-balanced, permanent program of public aid to forest owners in the farming district. In this permanent program, a reasonable share of the responsibility and expense would have to be accepted by the landowner.

Possible Remedies

The forestry problem in southern Minnesota has many things in common with other farm-management problems and logically should be approached in the same way. The situation calls for educational work, some well-directed public aid, and scientific research.

Education.

The Agricultural Extension Service, county Farm Bureaus, soil-conservation agencies, and other groups which contact woodland owners have made some progress in the demonstration of forest management and in the

stimulation of shelterbelt and wood-lot planting, but much remains to be done to overcome the apathy and lack of technical knowledge that stand in the way of a satisfactory program.

Extension. -- An adequate extension set-up is a vital necessity for the rehabilitation of farm woods. The logical steps in farm-forestry extension would seem to be these:

1. An aggressive educational campaign under the leadership of the State Extension Service and directed by the county agricultural agents (or special assistants appointed to help them). They might work through a committee of four or five prominent farmers in each township. Cooperation of other State and Federal bureaus should be sought in conducting this campaign.

2. Establishment of one or two carefully planned demonstrations in each township to show methods of planting, of harvesting timber, and of improving stand quality and composition. Advantage should be taken of the soil-conservation work or any emergency activities in the vicinity.

3. Collection and dissemination of information on log markets, prices, and transportation costs, to aid farmers in disposing of wood-lot products. Responsibility would rest with the extension forester, but technical help could doubtless be obtained from research agencies.

4. Exploration of the possibilities of cooperative marketing of wood-lot products. Where possibilities exist, definite aid might be given in organization and operation. Here, again, responsibility would rest with the extension forester, but technical help should be forthcoming from other agencies, such as the State Department of Agriculture, where a set-up now exists for helping farmers and others to establish cooperative enterprises.

In comparing the returns from wood lot and pasture, farmers are inclined to judge on the basis of the poorest kind of woodland management. Opportunity should be taken to explain and demonstrate possible returns from a proper type of woods management. For example, if one of the better farm-woods tracts consisting of mixed upland and bottomland hardwoods were fenced from grazing and handled exclusively for timber production, yields would be much higher.

With careful selective logging, annual yields from such a tract could readily be increased to 75 board feet of saw timber per acre plus 0.4 cord of rough wood. If marketing facilities were available, so that full value could be obtained for the better logs, an average return of $10 per thousand board feet plus 50 cents per cord would be quite within reason. In that case the net return per acre would be 95 cents, which

compares favorably with the combined return from grazing and wood production on the present partially pastured areas.

The case for a well-managed wood lot is even stronger when it is considered that the average farm needs about 1,000 board feet of lumber, 7 cords of fuel wood, and 54 fence posts each year. If these cannot be obtained on the farm, the farm owner will have to buy them at prices substantially higher than the cost of growing, due to transportation and commission expenses.

A stimulating farm example. -- One farmer in western Rice County has 312 acres of land, of which 7 acres are devoted to buildings, farmyard, and roads; 175 acres to cultivated crops; 65 acres to meadow; and 65 acres to woods. The woodland supports a stand of about 8,000 board feet per acre of old-growth sugar maple, basswood, elm, and oak. It lies along a ridge on the north side of the farm, and not only exerts a modifying effect upon winter winds, but undoubtedly serves to retain the soil on this critical area and protect the croplands below.

Each winter the farmer cuts from his wood lot about 8,000 board feet of sawlogs, mostly from trees more than 16 inches in diameter, and 39 cords of additional wood from dead and inferior trees and tops and limbs of the sawlog trees. In an average year he uses on the farm 2,000 board feet of lumber, 12 standard cords of fuel wood, and 200 wooden fence posts, leaving 6,000 board feet and 23 cords for sale.

The farmer has a small circular saw with tractor power with which he cuts lumber from his sawlogs. This lumber he sells for $30 a thousand board feet. The cordwood sells for $5 a cord as fuel. The market for these products is in neighboring communities and on prairie farms to the west.

The yearly cash income to this farmer from the sale of wood products is $295. The value of wood used on the farm (assuming the price of posts to be 15 cents each) is $150. The gross annual yield of this wood lot and mill is therefore $445, or $6.85 per acre of woods. The farmer usually saws for his neighbors about 15,000 board feet of logs yearly, for which he charges $8 a thousand feet. This pays for all fuel, labor, and depreciation on the mill.

State and Federal Aid.

To supplement the educational work under the leadership of the extension forester, there should be a permanent plan of direct aid to farmers and other landowners in the district. This work logically should fall to the State Conservation Department. It would consist of such items as these:

1. Establishment of dependable fire protection.

2. Distribution of certified planting stock, free or at a nominal price. This stock could be produced in State nurseries or purchased on bid from commercial nurseries. Under

the Clarke-McNary Act the Federal Government can share the expense of producing tree seedlings for farmers.

3. Help with planting or with stand-improvement operations. It is felt that the State would be justified in assisting farmers with small tracts as a demonstration of possibilities. Advantage should be taken of C.C.C. camps and other emergency organizations wherever possible. Cooperation from the Soil Conservation Service should likewise be sought.

4. Elimination of submarginal farms, consolidation of small farms into more economic units, and reduction of tenancy. These are long-time objectives sought by the public for the general welfare and which, insofar as they can be attained, should improve the forest situation.

5. Tax reform. Authorities differ as to the merits of any tree-bounty law or other special tax law designed to stimulate forestry, but there can be no doubt that the present unclassified real-estate tax is unfavorable to forestry.

There are two possible ways of bettering the tax system. One is to set up a special appraiser's classification of "woodland" on which can be placed a scientific valuation based upon productivity and to which the regular tax levy would apply. The other possibility would be, as in Wisconsin, frankly to subsidize the owner of steep woodlands who meets certain stipulations, by giving him complete exemption or setting a nominal valuation upon his land.

Research.

To provide technical information as a basis for both educational and service work, an enlarged program of research seems desirable. The following matters would doubtless have prominence in such a program:

1. Planting. Study of planting methods, spacing, cultivation, and species adapted to various localities.

2. Management. Careful record of costs and effects of thinning, weeding, and sanitation cutting, so as to provide a basis for judging the feasibility of various management measures.

3. Protection. Study of insects and fungi operating in the region and possible methods of controlling them. Invention of better equipment for fire suppression.

4. Utilization. Development of improved machinery for logging and milling (e.g., power saws, portable band mills, machines for making cheap flooring from inferior timber).

5. Marketing. Survey of the market situation, including a study of the amounts of timber available in various localities as a basis for cooperative-marketing plans.

6. Farm management. An economic study of individual farms in southern Minnesota to determine what difficulties are involved in returning steep pasture land to forest.

Many of these problems could be studied in connection with the demonstration plots set out in various counties of the State. They would involve merely a clear record of what was done, and what it cost, and provision for a check-up at a later date to see what was accomplished.

Several agencies are equipped to do research of this kind, notably the Division of Forestry, University of Minnesota; the Lake States Forest Experiment Station at University Farm, St. Paul; and the Forest Products Laboratory at Madison, Wisconsin. In practice, these three agencies would doubtless cooperate in handling phases of the job.

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A P P E N D I X

Table I. -- Classification of Land According to U. S. Census of Agriculture, 1935, in the Hardwood and Prairie Districts of Minnesota

Class of land	Both Districts	Hardwood District	Prairie District
	Thousand acres	Thousand acres	Thousand acres
All land	32,208	11,356	20,852
Land in farms	28,519	9,967	18,552
Crop land	19,024	5,545	13,479
Cleared pasture	4,333	1,732	2,601
Woodland pasture	2,726	1,833	893
Woodland (not pastured)	630	282	348
Other land	1,806	575	1,231
Land outside of farms	3,689	1,389	2,300
Percent of land in farms	88.5	87.8	89.0
Percent of farm land wooded	11.8	21.2	6.7

Table II. -- Area of Forest Land, by Cover Types and Condition

Forest cover type	Both Districts			
	All classes	Saw timber	Cordwood	Restocking
	Acres	Acres	Acres	Acres
Pine:				
White pine	8,800	1,700	1,200	5,900
Norway pine	9,100	2,600	3,600	2,900
Jack pine	8,500	1,900	3,600	3,000
All pine	26,400	6,200	8,400	11,800
Upland hardwoods:				
Maple-basswood	492,200	181,300	175,500	135,400
Oak	433,000	104,900	246,700	81,400
All upland hardwoods	925,200	286,200	422,200	216,800
Bottomland hardwoods	226,200	51,900	74,700	99,600
Spruce-balsam	14,000	2,600	6,400	5,000
Coniferous swamp:				
Spruce	47,400	800	25,500	21,100
Tamarack	77,000	500	26,800	49,700
Cedar	15,800	1,000	8,000	6,800
Nonproductive	161,400	.....	1,700	159,700
All coniferous swamp	301,600	2,300	62,000	237,300
Miscellaneous:				
Aspen-birch	580,100	11,200	98,200	470,700
Scrub aspen	565,500	.....	103,100	462,400
Scrub oak	405,500	.....	285,400	120,100
Deforested	1,117,000	.....	.....	.....
All miscellaneous	2,668,100	11,200	486,700	1,053,200
All cover types	4,161,500	360,400	1,060,400	1,623,700
Prairie shelterbelts	86,300	.....	.....	.....

Classes, in the Hardwood and Prairie Districts of Minnesota, 1934

Hardwood District				Prairie District			
All classes	Saw timber	Cordwood	Restocking	All classes	Saw timber	Cordwood	Restocking
Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
7,200	1,600	800	4,800	1,600	100	400	1,100
7,200	2,400	2,400	2,400	1,900	200	1,200	500
6,400	1,600	2,400	2,400	2,100	300	1,200	600
20,800	5,600	5,600	9,600	5,600	600	2,800	2,200
393,500	145,000	140,300	108,200	98,700	36,300	35,200	27,200
274,000	66,500	156,300	51,200	159,000	38,400	90,400	30,200
667,500	211,500	296,600	159,400	257,700	74,700	125,600	57,400
153,000	35,200	50,500	67,300	73,200	16,700	24,200	32,300
4,000	800	1,600	1,600	10,000	1,800	4,800	3,400
7,200	.....	3,200	4,000	40,200	800	22,300	17,100
52,800	.....	21,600	31,200	24,200	500	5,200	18,500
.....	.....	.....	.....	15,800	1,000	8,000	6,800
800	.....	.....	800	160,600	.....	1,700	158,900
60,800	.....	24,800	36,000	240,800	2,300	37,200	201,300
383,500	11,200	62,400	309,900	196,600	.....	35,800	160,800
.....	.....	.....	.....	565,500	.....	103,100	462,400
338,100	.....	238,000	100,100	67,400	.....	47,400	20,000
690,600	.....	.....	.....	426,400	.....	.....	.....
1,412,200	11,200	300,400	410,000	1,255,900	.....	186,300	643,200
2,318,300	264,300	679,500	683,900	1,843,200	96,100	380,900	939,800
.....	.....	.....	.....	86,300	.....	.....	.....

Table III. — Summary of Timber Volume in the Hardwood and Prairie Districts of Minnesota, 1934

Product	Unit of Measure	Volume of standing timber			Equivalent in thousand cubic feet of solid wood, both districts	
		Both Districts	Hardwood District	Prairie District	Volume	Percent
Saw timber....	M bd.ft.[1]	1,775,560	1,286,610	488,950	331,610	18.5
Pulpwood.....	Cords...	1,000,000	300,000	700,000	(2)	(2)
Poles (white cedar)	Pieces..	353,000	.....	353,000	3,150	0.2
Posts (round cedar)	Pieces..	297,000	.....	297,000	780	.....
Posts (split cedar)	Pieces..	440,000	.....	440,000	680	.....
Cordwood:						
Small trees	Cords...	10,891,000	6,864,000	4,027,000	784,270	43.6
Tops & limbs	Cords...	4,009,000	2,905,000	1,104,000	240,250	13.4
Cull.....	Cords...	6,453,000	4,826,000	1,627,000	437,090	24.3
All cordwood	Cords...	21,353,000	14,595,000	6,758,000	1,461,610	81.3
All products..	.....	.....	.....	.....	1,797,830	100.0

1/ M bd.ft. (thousand board feet), Scribner decimal C log rule.

2/ The cubic-foot equivalent of pulpwood is included under cordwood.

Table IV. -- Average Volume of Timber per Acre, by Forest Cover Types and Condition Classes, in the Hardwood and Prairie Districts, Minnesota, 1934

Forest cover type	In saw-timber stands		In cordwood stands		In restocking areas	
	Board feet (Scrib.)	Cubic feet	Board feet (Scrib.)	Cubic feet	Board feet (Scrib.)	Cubic feet
Pine:						
White pine	2,529	912	875	858	141	215
Norway pine	3,008	1,112	356	614	.....	3
Jack pine	3,016	989	258	481	27	23
Upland hardwoods:						
Maple-basswood	3,589	1,487	536	614	191	149
Oak	2,725	1,366	553	761	59	77
Bottomland hardwoods	3,242	1,334	601	607	174	144
Spruce-balsam	3,765	1,692	624	730	432	270
Coniferous swamp:						
Spruce	3,150	1,638	352	714	24	77
Tamarack	2,360	1,200	393	572	28	60
Cedar	1,420	2,120	340	1,130	65	275
Nonproductive	.....	.....	76	318	.....	6
Miscellaneous:						
Aspen-birch	2,763	1,495	114	623	8	41
Scrub oak	.....	.....	236	565	15	53

Table V. -- Volume of Saw Timber, By Species and Condition Classes, in the Hardwood District of Minnesota, 1934

Species	Standing volume in thousand board feet (Scribner)			
	In all stands	In old-growth stands	In second-growth stands	On cordwood, restocking, or deforested land
Softwoods:				
White pine	11,340	2,960	4,220	4,160
Norway pine	6,340	3,100	2,380	860
Jack pine	4,600	.....	4,300	300
Balsam fir	4,340	.....	2,710	1,630
Spruce	610	.....	90	520
Tamarack	13,730	.....	290	13,440
All softwoods	40,960	6,060	13,990	20,910
Hardwoods:				
Poplar	65,200	12,970	24,170	28,060
Paper birch	11,770	1,630	1,920	8,220
Red maple	29,760	9,660	10,310	9,790
Sugar maple	145,780	101,720	28,940	15,120
Yellow birch	760	.....	40	720
Basswood	204,590	89,810	70,980	43,800
Elm	271,470	114,200	77,320	79,950
Oak	417,740	83,520	164,820	169,400
Miscellaneous	98,580	22,160	38,470	37,950
All hardwoods	1,245,650	435,670	416,970	393,010
All species	1,286,610	441,730	430,960	413,920

Table VI. — Volume of Saw Timber, by Species and Condition Classes, in the Prairie District of Minnesota, 1934

Species	Standing volume in thousand board feet (Scribner)			
	In all stands	In old-growth stands	In second-growth stands	On cordwood, restocking, or deforested land
Softwoods:				
White pine	12,420	1,750	2,810	7,860
Norway pine	3,420	.....	950	2,470
Jack pine	2,360	.....	980	1,380
Balsam fir	3,610	360	2,010	1,240
Spruce	16,610	1,080	5,550	9,980
Tamarack	5,710	.....	1,430	4,280
All softwoods	44,130	3,190	13,730	27,210
Hardwoods:				
Poplar	32,000	3,220	7,160	21,620
Paper birch	6,540	460	3,400	2,680
Red maple	7,700	1,740	4,100	1,860
Sugar maple	39,330	27,670	7,970	3,690
Yellow birch	140	.....	80	60
Basswood	52,030	23,740	16,960	11,330
Elm	132,620	36,600	33,860	62,160
Oak	152,680	28,970	69,480	54,230
Miscellaneous	21,780	4,220	9,120	8,440
All hardwoods	444,820	126,620	152,130	166,070
All species	488,950	129,810	165,860	193,280

Table VII. -- Volume of Pulpwood, by Species and Condition Classes, in the Hardwood and Prairie Districts of Minnesota, 1934

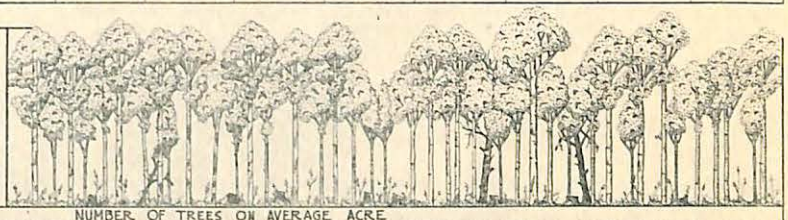
Species	Volume in standard cords				
	In all stands		In saw-timber stands	In cordwood stands	On restocking or deforested areas
	Volume	Percent			
Both Districts:					
Poplar	672,000	67.20	37,000	450,000	185,000
Pine	18,000	1.80	3,000	12,000	3,000
Balsam fir	49,000	4.90	24,000	23,000	2,000
Spruce	162,000	16.20	11,000	135,000	16,000
Tamarack	99,000	9.90	2,000	76,000	21,000
All species	1,000,000	100.00	77,000	696,000	227,000
Hardwood District:					
Poplar	197,000	65.66	27,000	130,000	40,000
Pine	2,000	0.67	2,000	.....	.....
Balsam fir	22,000	7.33	12,000	9,000	1,000
Spruce	17,000	5.67	1,000	13,000	3,000
Tamarack	62,000	20.67	1,000	48,000	13,000
All species	300,000	100.00	43,000	200,000	57,000
Prairie District:					
Poplar	475,000	67.86	10,000	320,000	145,000
Pine	16,000	2.29	1,000	12,000	3,000
Balsam fir	27,000	3.86	12,000	14,000	1,000
Spruce	145,000	20.71	10,000	122,000	13,000
Tamarack	37,000	5.28	1,000	28,000	8,000
All species	700,000	100.00	34,000	496,000	170,000

Table VIII. -- Average Acres of Northern-Hardwood Types in Southern Minnesota, 1934

AVERAGE OF WELL STOCKED OLD GROWTH SAWTIMBER STAND

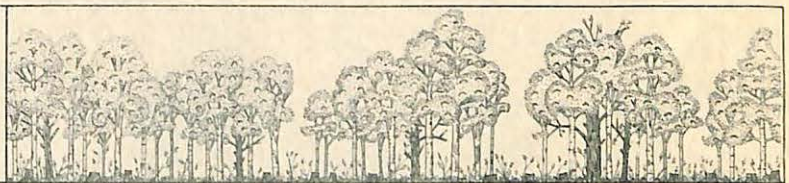
DIAMETER BREAST HGHT.	NUMBER OF TREES ON AVERAGE ACRE											
	SUGAR MAPLE	BASSWOOD	ELM	RED OAK	WHITE OAK	MISC. BETTER	ASPEN	PAPER BIRCH	RED MAPLE	MISC. INFERIOR	TOTAL	CULL
2	64.29		7.14							135.72	207.15	
4	17.14	2.86	8.57							5.71	34.28	
6	10.71	2.86	1.79	.36	.36	1.07				1.07	18.22	
8	6.78	2.14	.71		.36	.71			.36	1.07	12.13	.36
10	6.78	2.86	2.50							.36	12.50	.36
12	7.86	2.50	3.21	.36			.36			1.79	16.08	.71
14	10.00	2.86	1.07		.36						14.29	
16	7.14	3.21	1.43	.36				.36		.71	13.21	.36
18	4.64	1.79			.36						6.79	.36
20-22	3.57	1.78	.71	.36	.36						6.78	.71
24-26	1.43	1.07	1.78	.36	.71						5.35	.36
28+	.36		1.07								1.43	1.79
TOTAL	140.70	23.93	29.98	1.80	2.51	1.78	.36	.36	.36	14.43	348.21	5.01
VOLUME BD.FT. (CRIBNER)	4518.00	1866.00	1793.00	239.00	325.00		15.00	48.00		181.00	8985.00	
VOLUME CU.FT.	1408.00	567.00	534.00	71.00	104.00	6.00	6.00	13.00	2.00	69.00	2780.00	39.00

AVERAGE OF MEDIUM STOCKED OLD GROWTH SAWTIMBER STAND



DIAMETER BREAST HGHT.	NUMBER OF TREES ON AVERAGE ACRE												
	SUGAR MAPLE	BASSWOOD	ELM	RED OAK	WHITE OAK	MISC. BETTER	ASPEN	PAPER BIRCH	MISC. INFERIOR	WHITE PINE	BALSAM FIR	TOTAL	CULL
2	15.38								38.46			53.84	7.69
4	24.62	15.38	3.08						15.38			58.46	3.08
6	10.43	15.07	1.16	1.74					12.17			40.57	1.16
8	8.08	11.92	2.69	3.85	.77	.38			6.54		.38	34.61	2.69
10	5.00	6.54	1.92	2.69	.38	.38	.38	1.54	3.46		.38	22.67	1.54
12	6.54	9.61	1.92	3.85				.38	1.54		.77	24.61	2.31
14	3.46	4.62	2.69	1.54					.38		.77	13.46	1.15
16	1.15	3.46	1.15	.77						.77		7.30	1.15
18		4.23	.38	.38	.38					.38		5.75	.38
20-22				.77	.38							1.15	1.15
24-26		.38	.77									1.15	
TOTAL	74.66	71.21	15.76	15.59	1.91	.76	.38	1.92	77.93	1.15	2.30	263.57	22.30
VOLUME BD.FT. (CRIBNER.)	791.00	2180.00	707.00	658.00	129.00	8.00	7.00	27.00	156.00	166.00	100.00	4929.00	
VOLUME CU.FT.	386.00	818.00	261.00	265.00	48.00	7.00	5.00	22.00	132.00	45.00	36.00	2025.00	214.00

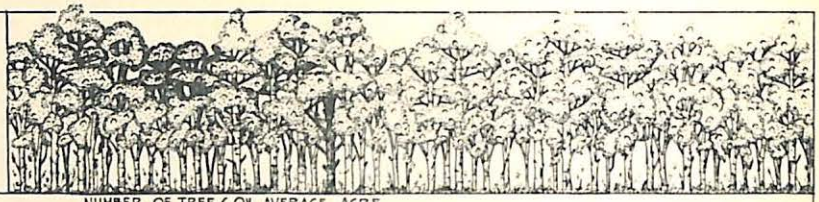
AVERAGE OF POORLY STOCKED SECOND GROWTH SAWTIMBER STAND



DIAMETER BREAST HGHT.	NUMBER OF TREES ON AVERAGE ACRE													
	SUGAR MAPLE	BASSWOOD	ELM	RED OAK	WHITE OAK	Y. BIRCH	MISC. BETTER	ASPEN	PAPER BIRCH	RED MAPLE	SCRUB OAK	MISC. INFERIOR	BALSAM FIR	TOTAL	CULL
2	18.99	7.59	8.86	1.27					2.53			32.91		72.15	
4	14.68	9.11	5.57	2.03	2.03		1.01		3.04	1.01		19.75	.51	58.74	4.05
6	6.26	9.76	5.02	1.14	1.90		2.37		.57	.38	.28	8.15		37.35	3.22
8	2.75	7.64	4.06	1.31	2.19	.06	.56	1.52	.37	.50	.25	2.19	.06	22.80	2.81
10	1.63	5.44	3.31	.62	2.00		.62	1.06	.62		.25	1.63	.06	16.80	3.37
12	1.81	4.19	3.44	1.31	1.06		.25	.62	.19	.06	.38	1.37	.06	14.62	2.63
14	.94	3.31	2.25	.56	.87			.50		.06	.19	.50		8.68	1.44
16	.75	.87	1.56	.56	.12						.13	.44		4.43	.75
18	.06	.31	.31	.13	.19									1.00	.81
20-22	.13	.32	.37	.19	.06						.12	.06		1.25	.75
24-26			.19								.06			.25	.43
28+			.06											.06	.06
TOTAL	48.00	48.34	35.00	9.12	10.42	.06	4.81	3.70	7.32	2.01	1.66	67.00	.69	238.13	20.32
VOLUME BD.FT. (CRIBNER)	312.00	763.00	735.00	235.00	165.00		26.00	33.00	12.00	10.00		221.00	4.00	2516.00	
VOLUME CU.FT.	92.00	353.00	301.00	94.00	92.00		21.00	27.00	13.00	6.00	18.00	102.00	2.00	1175.00	275.00

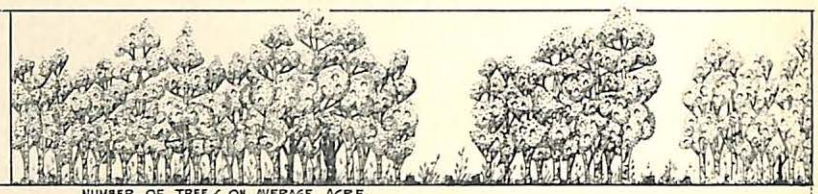
Table IX. -- Average Acres of Oak Cordwood and Wooded Pastures in Southern Minnesota, 1934

AVERAGE OF WELL /TOCKED OAK CORDWOOD /TAND/



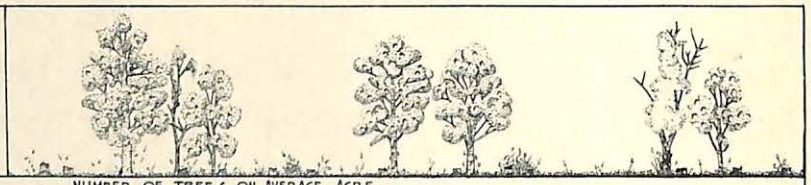
DIAMETER BREAST HGHT	NUMBER OF TREE/ ON AVERAGE ACRE. RED OAK	WHITE OAK	/CRUB OAK	BA//WD.	ELM	/UGAR MAPLE	MI/C.BETTER	A/PEN	PAPER BIRCH	MI/C.INFERIOR	CEDAR	TOTAL	ADDL. CULL/
2	6.45	16.13		3.23	9.68	3.23			6.45	22.58		67.75	
4	14.19	30.97			2.58	1.29	3.87	1.29		2.58		56.77	
6	30.00	21.94	2.26	.81	.48	.48	2.58	1.29	.81	.16		60.81	.81
8	32.10	17.26	4.52	1.13	.48	.16	1.77	.48	1.45			59.35	2.10
10	23.55	9.19	4.03		.32		.48	.65	.32		.16	38.70	1.13
12	12.26	3.06	3.39	.32	.48			.48				19.99	1.29
14	3.55	.97	2.10					.16				6.78	.32
16	1.29	.65	1.29				.32					3.55	.32
18			.65									.65	
20-22			1.29									1.29	.48
TOTAL	123.39	100.17	19.53	5.49	14.02	5.16	9.02	4.35	9.03	25.32	.16	315.64	6.45
VOLUME BD.FT. (/CRIBNER.)	843.00	228.00		13.00	18.00		36.00	38.00	4.00			1180.00	
VOLUME CU.FT.	809.00	284.00	174.00	13.00	14.00	2.00	29.00	24.00	12.00		1.00	1362.00	87.00

AVERAGE OF MEDIUM /TOCKED OAK CORDWOOD /TAND/



DIAMETER BREAST HGHT	NUMBER OF TREE/ ON AVERAGE ACRE. RED OAK	WHITE OAK	/CRUB OAK	BA//WD.	ELM	/UGAR MAPLE	MI/C.BETTER	A/PEN	PAPER BIRCH	RED MAPLE	MI/C.INFERIOR	CEDAR	TOTAL	ADDL. CULL/
2	1.54	12.31	7.69	12.31				1.54			6.15	1.54	43.08	1.54
4	11.08	20.31	12.92	6.77	.62		1.23	8.00		.62	3.69		65.24	3.69
6	28.56	17.44	7.97	2.84	.63	.08	3.63	5.21	1.42	.32	.08		68.10	1.74
8	18.86	10.76	7.80	.76	.45	.08	1.97	2.88	1.29	.15	.08		45.08	3.11
10	11.14	4.47	5.68	.53	.23	.08	.83	.23	.30	.08			23.57	1.44
12	5.15	1.44	3.18	.30	.08		.08	.08	.08				10.47	1.14
14	1.89	.68	2.42	.23			.08						5.30	.38
16	.45	.23	.91	.08			.08						1.75	.38
18		.08	.61										.77	.15
20-22			.61										.61	.38
24-26			.08										.08	
28+														.08
TOTAL	78.67	67.72	49.87	23.90	2.01	.24	7.90	17.94	3.09	1.17	10.00	1.54	264.05	14.03
VOLUME. BD.FT. (/CRIBNER.)	374.00	121.00		52.00	5.00	4.00	19.00	7.00	5.00				587.00	
VOLUME CU.FT.	423.00	166.00	171.00	29.00	6.00	2.00	31.00	31.00	13.00	3.00			875.00	107.00

AVERAGE OF WOODED PA/TURE AREA/



IAMETER BR.HGHT.	NUMBER OF TREE/ ON AVERAGE ACRE. RED OAK	WHITE OAK	SCRUB OAK	BASSWD.	ELM	/UGAR MAPLE	Y. BIRCH	MISC.BETTER	ASPEN	P. BIRCH	RED MAPLE	MI/C.INFERIOR	W. PINE	W./PRUCE	CEDAR	TAMARACK	TOTAL	ADDL.CULLS
2		.63	2.53														3.16	1.77
4	.25	3.04	8.35		.25			.51	2.03	.51	.76	3.04					18.73	2.28
6	.51	1.09	2.27	.10	.32	.11	.02	.29	.62	.54	.11	.59		.02	.05	.10	6.73	1.65
8	.15	.62	1.84	.20	.57	.12		.19	.24	.13	.12	.44		.01		.06	4.69	1.68
10	.06	.41	1.26	.21	.29	.09		.06	.09		.03	.17	.01			.01	2.68	1.86
12	.08	.28	.61	.14	.37	.06		.02	.06		.02	.14	.01			.01	1.79	1.45
14	.07	.22	.30	.12	.32	.03		.01	.02		.02	.08					1.19	.93
16	.04	.07	.19	.11	.24	.03					.01	.03	.01				.72	.63
18	.04	.01	.08	.03	.11							.01					.27	.55
20-22		.03	.04	.01	.10				.02			.01					.21	.54
24-26			.01	.01	.05							.01					.08	.22
28+					.01												.01	.09
TOTAL	1.20	6.40	17.48	.93	2.63	.44	.02	1.08	3.08	1.18	1.07	4.52	.03	.03	.05	.18	40.26	13.15
VOLUME B.F. (/CRIBNER)	16.00	33.00		35.00	103.00	7.00		1.00	9.00		3.00	25.00	2.00				234.00	
VOLUME CU.F.	9.00	22.00	30.00	14.00	47.00	5.00		3.00	7.00	2.00		12.00					146.00	179.00

Table X. -- Primary Wood-Using Industries, Including Number of Mills, Employment, and Production, in the Hardwood and Prairie Districts of Minnesota, 1934

Type of mill	Number of mills	Number of men employed 1933	Output 1933	Percent of 1929-33 average
Sawmills: Annual production -				
More than 5,000 M ft.b.m.[1]	None	.....	.....	.....
1,000-5,000 M ft.b.m.....	1	10	1,033 M ft.b.m.[1]	100.0
100-1,000 M ft.b.m.....	66	375	15,449 M ft.b.m...	93.4
Less than 100 M ft.b.m.....	549	2,030	18,554 M ft.b.m...	98.6
All sawmills.....	616	2,415	35,036 M ft.b.m...	96.3
Pulp mills.....	2	86	19,646 cords[2].....	100.0
Lath mills.....	3	29	253 M pieces...	100.0
Veneer mills.....	6	27	455 M ft.b.m...	44.3
Cooperage mills.....	2	15	513 M ft.b.m.	36.0
Excelsior mills.....	1	12	3,438 cords[2].....	50.0
Shingle mills.....	2	5	116 M pieces...	82.3
Match factories.....	None	.....	.....	.....
All mills.....	632	2,589	.....	.....

[1] M ft.b.m. (thousand feet board measure), lumber tally.

[2] Amount of wood used.

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Table XI. -- Lumber Production of Sawmills, by Species, in the Hardwood and Prairie Districts of Minnesota, 1933

Species	Lumber production in thousand feet board measure[1]		
	Both Districts	Hardwood District	Prairie District
Softwoods:			
White pine	1,447	1,091	356
Norway pine	1,697	1,588	109
Jack pine	333	191	142
Balsam fir	134	54	80
Spruce	219	107	112
Cedar	9	5	4
Tamarack	596	429	167
All softwoods	4,435	3,465	970
Hardwoods:			
Poplar	3,263	2,123	1,140
Birch	308	86	222
Maple	1,508	286	1,222
Basswood	4,742	3,702	1,040
Elm	8,487	4,646	3,841
Oak	11,508	7,548	3,960
Ash	684	578	106
Miscellaneous	101	78	23
All hardwoods	30,601	19,047	11,554
All species	35,036	22,512	12,524
Percent of 1929-33 average	96.3	94.3	100.0

1/Lumber tally.

Table XII. -- Estimated Annual Cut of All Merchantable[1] Products in the Hardwood and Prairie Districts of Minnesota, 1934-1944

Product	Unit of measure	Annual cut		
		Both Districts	Hardwood District	Prairie District
Sawlogs and tie cuts	M bd.ft.[2]	29,478	19,847	9,631
Veneer logs	M bd.ft.	761	744	17
Cabin poles	M bd.ft.	190	115	75
Piling	M bd.ft.	321	321	.....
Cooperage stock	M bd.ft.	1,200	863	337
Shingle stock	M bd.ft.	12	12	.....
Pulpwood	M bd.ft.	32	17	15
Do	Cords	7,695	2,701	4,994
Excelsior bolts	Cords	4,166	4,166	.....
Fence posts	Cords	67,655	49,282	18,373
Fuel wood	M bd.ft.	28,935	17,971	10,964
Do	Cords	270,418	188,119	82,299

[1] Pulpwood, posts, fuel wood, and lath obtained from tops and limbs of saw-timber trees, from cull and dead trees, deadheads, trees less than 5 inches in diameter at breast height, and from mill waste, are not included in this and the four following tables.

[2] M bd.ft. (thousand board feet), Scribner decimal C log rule.

Table XIII. -- Estimated Annual Cut of Merchantable[1] Sawlog Products, by Species, in the Hardwood District of Minnesota, 1934-1944

Species	Annual cut in thousand board feet (Scribner)					
	All products	Sawlogs and tie cuts	Veneer and cooperage stock	Piling, cabin poles, shingle stock	Pulp-wood	Fuel wood
Softwoods:						
White pine	726	698	16	12	.....	.....
Norway pine	185	175	.....	10	.....	.....
Jack pine	117	80	.....	20	17	.....
Balsam fir	40	30	.....	10	.....	.....
Spruce	84	69	.....	15	.....	.....
Cedar	4	4	.....	.....	.....	.....
Tamarack	1,070	401	.....	.....	.....	669
All softwoods	2,226	1,457	16	67	17	669
Hardwoods:						
Poplar	2,983	2,037	157	60	.....	729
Birch	637	92	280	.....	.....	265
Maple	405	291	.....	.....	.....	114
Basswood	6,349	3,434	1,063	.....	.....	1,852
Elm	9,759	4,285	91	.....	.....	5,383
Oak	16,281	7,697	.....	321	.....	8,263
Miscellaneous	1,250	554	.....	.....	.....	696
All hardwoods	37,664	18,390	1,591	381		17,302
All species	39,890	19,847	1,607	448	17	17,971

[1]/See footnote 1, p.51.

Table XIV. -- Estimated Annual Cut of Merchantable[1/] Sawlog Products, by Species, in the Prairie District of Minnesota, 1934-1944

Species	Annual cut in thousand board feet (Scribner)					
	All products	Sawlogs and tie cuts	Veneer and cooperage stock	Cabin poles	Pulp-wood	Fuel wood
Softwoods:						
White pine	253	253				
Norway pine	72	67		5		
Jack pine	146	136		10		
Balsam fir	72	67		5		
Spruce	104	84		5	15	
Cedar	3	3				
Tamarack	245	110				135
All softwoods	895	720		25	15	135
Hardwoods:						
Poplar	5,135	711	17	50		4,357
Birch	76	76				
Maple	1,140	981				159
Basswood	2,991	737	337			1,917
Elm	6,061	3,129				2,932
Oak	4,035	3,180				855
Miscellaneous	706	97				609
All hardwoods	20,144	8,911	354	50		10,829
All species	21,039	9,631	354	75	15	10,964

[1/] See footnote 1, p. 51.

Table XV. -- Estimated Annual Cut of Merchantable[1] Cordwood Products, by Species, in the Hardwood District of Minnesota, 1934-1944

Species	Annual cut in standard cords				
	All products	Pulp-wood	Excelsior bolts	Fence posts	Fuel wood
Softwoods:					
Jack pine	135	64	.....	71	.....
Spruce	2,637	2,637	.....	.....	.....
Cedar	93	.....	.....	93	.....
Tamarack	14,225	.....	.....	2,449	11,776
All softwoods	17,090	2,701	.....	2,613	11,776
Hardwoods:					
Poplar	64,473	.....	2,969	2,220	59,284
Birch	16,194	.....	.....	.....	16,194
Maple	1,635	.....	.....	1,068	567
Basswood	4,943	.....	1,197	.....	3,746
Elm	14,466	.....	.....	93	14,373
Oak	102,594	.....	.....	42,459	60,135
Miscellaneous	22,873	.....	.....	829	22,044
All hardwoods	227,178	.....	4,166	46,669	176,343
All species	244,268	2,701	4,166	49,282	188,119

[1]/See footnote 1, p.51.

Table XVI. -- Estimated Annual Cut of Merchantable[1] Cordwood Products, by Species, in the Prairie District of Minnesota, 1934-1944

Species	Annual cut in standard cords			
	All products	Pulp-wood	Fence posts	Fuel wood
Softwoods:				
Jack pine	93	51	42	.....
Balsam fir	245	179	66	.....
Spruce	2,855	1,019	.....	1,836
Cedar	387	.....	387	.....
Tamarack	10	.....	10	.....
All softwoods	3,590	1,249	505	1,836
Hardwoods:				
Poplar	56,236	3,745	2,445	50,046
Birch	1,985	.....	.....	1,985
Maple	347	.....	347	.....
Basswood	3,493	.....	.....	3,493
Elm	4,346	.....	33	4,313
Oak	24,294	.....	14,981	9,313
Miscellaneous	11,375	.....	62	11,313
All hardwoods	102,076	3,745	17,868	80,463
All species	105,666	4,994	18,373	82,299

[1] See footnote 1, p.51.

Table XVII. -- Estimated Annual Depletion of Timber, by Forest Cover Types and Kinds of Products, in the Hardwood District of Minnesota, 1934-1944

Total Volume -- in Thousand Cubic Feet

Forest cover type (grouped)	Total annual depletion	Cut for sawlog products	Cut for pulpwood	Cut for posts, fuel, etc.	Fire and other losses
White and Norway pine	324	130	.....	110	84
Jack pine	83	32	10	14	27
Hardwoods[1]	25,215	5,792	12	13,476	5,935
Spruce-balsam	131	18	12	64	37
Coniferous swamp	1,560	103	171	1,011	275
Aspen, scrub oak, etc.	14,091	1,421	12	7,774	4,884
All cover types	41,404	7,496	217	22,449	11,242

Saw-Timber Trees -- in Thousand Board Feet (Scribner)

White and Norway pine	662	582	.....	31	49
Jack pine	157	107	17	.....	33
Hardwoods[1]	37,503	16,557	.....	14,266	6,680
Spruce-balsam	114	61	.....	20	33
Coniferous swamp	925	316	.....	484	125
Aspen, scrub oak, etc.	9,375	4,279	.....	3,170	1,926
All cover types	48,736	21,902	17	17,971	8,846

Trees of Less Than Sawlog Size -- in Cords

White and Norway pine	2,565	.....	.....	1,537	1,028
Jack pine	523	.....	64	209	250
Hardwoods[1]	176,454	.....	153	126,343	49,958
Spruce-balsam	1,394	.....	153	866	375
Coniferous swamp	18,202	.....	2,178	12,746	3,278
Aspen, scrub oak, etc.	159,033	.....	153	99,866	59,014
All cover types	358,171	.....	2,701	241,567	113,903

[1] Excluding aspen and scrub oak.

Table XVIII. -- Estimated Annual Depletion of Timber, by Forest Cover Types and Kinds of Products, Prairie District of Minnesota, 1934-1944

Total Volume -- in Thousand Cubic Feet

Forest cover type (grouped)	Total annual depletion	Cut for sawlog products	Cut for pulpwood	Cut for posts, fuel, etc.	Fire and other losses
White and Norway pine	46	13	.....	11	22
Jack pine	66	31	3	16	16
Hardwoods[1]	10,467	2,725	30	5,388	2,324
Spruce-balsam	346	55	13	167	111
Coniferous swamp	1,533	71	89	263	1,110
Aspen, scrub oak, etc.	8,658	602	262	4,619	3,175
All cover types	21,116	3,497	397	10,464	6,758

Saw-Timber Trees -- in Thousand Board Feet (Scribner)

White and Norway pine	81	62	.....	9	10
Jack pine	146	104	.....	27	15
Hardwoods[1]	17,586	7,716	.....	7,412	2,458
Spruce-balsam	696	187	3	366	140
Coniferous swamp	710	220	12	257	221
Aspen, scrub oak, etc.	5,435	1,771	.....	2,893	771
All cover types	24,654	10,000	15	10,964	3,615

Trees of Less Than Sawlog Size -- in Cords

White and Norway pine	412	.....	.....	134	278
Jack pine	324	.....	38	119	167
Hardwoods[1]	62,249	.....	383	41,672	20,194
Spruce-balsam	2,006	.....	153	881	972
Coniferous swamp	18,158	.....	1,083	2,672	14,403
Aspen, scrub oak, etc.	99,100	.....	3,337	55,194	40,569
All cover types	182,249	.....	4,994	100,672	76,583

[1] Excluding aspen and scrub oak.

Table XIX. -- Estimated Annual Growth of Timber, by Forest Cover Types and Kinds of Products, Hardwood District of Minnesota, 1934-1944

Forest cover type	Saw timber		Pulpwood		Total volume	
	Per acre	Total	Per acre	Total	Per acre	Total
	Bd.ft. Scrib.	M bd.ft. Scrib.	Cords	Cords	Cu.ft.	M cu.ft.
Pine:						
White pine	32	230	0.06	.....	33	240
Norway pine	36	260	0.01	.....	40	290
Jack pine	30	190	0.01	.....	20	130
All pine	33	680	0.03	.....	32	660
Upland hardwoods:						
Maple-basswood	34	13,190	.....	1,000	26	10,340
Oak	43	11,860	.....	1,000	28	7,660
All upland hardwoods	38	25,050	.....	2,000	27	18,000
Bottomland hardwoods	49	7,450	0.01	2,000	30	4,620
Spruce-balsam	35	140	0.08	.....	30	120
Coniferous swamp:						
Spruce	11	80	0.18	1,000	31	220
Tamarack	18	930	0.08	4,000	22	1,150
Cedar	.....	.....	.....	.....	.....	.....
Nonproductive	.....	.....	.....	.....	7	10
All coniferous swamp	17	1,010	0.09	5,000	23	1,380
Miscellaneous:						
Aspen-birch	14	5,430	0.05	19,000	24	9,320
Scrub oak	6	2,020	.....	.....	10	3,510
Deforested	5	3,220	.....	1,000	4	2,910
All miscellaneous	8	10,670	0.01	20,000	11	15,740
All cover types	19	45,000	0.01	29,000	17	40,520

Table XX. -- Estimated Annual Growth of Timber, by Forest Cover Types and Kinds of Products, Prairie District of Minnesota, 1934-1944

Forest Cover type	Saw timber		Pulpwood		Total volume	
	Per acre	Total	Per acre	Total	Per acre	Total
	Bd. ft. Scrib.	M bd. ft. Scrib.	Cords	Cords	Cu. ft.	M cu. ft.
Pine:						
White pine	31	50	0.11	.....	38	60
Norway pine	105	200	0.17	.....	58	110
Jack pine	71	150	0.25	1,000	38	80
All pine	71	400	0.18	1,000	45	250
Upland hardwoods:						
Maple-basswood	35	3,490	0.01	1,000	26	2,560
Oak	36	5,800	0.01	2,000	33	5,240
All upland hardwoods	36	9,290	0.01	3,000	30	7,800
Bottomland hardwoods	42	3,050	0.02	1,000	23	1,650
Spruce-balsam	49	490	0.10	1,000	31	310
Coniferous swamp:						
Spruce	24	980	0.16	6,000	23	940
Tamarack	7	180	0.05	1,000	7	160
Cedar	13	200	0.05	1,000	24	380
Nonproductive	.....	20	0.03	5,000	5	770
All coniferous swamp	6	1,380	0.06	13,000	9	2,250
Miscellaneous:						
Aspen	15	2,870	0.04	9,000	19	3,660
Scrub oak	7	480	0.01	1,000	10	690
Deforested	3	1,420	.....	.....	3	1,320
All miscellaneous	4	4,770	0.01	10,000	5	5,670
All cover types	11	19,380	0.02	29,000	10	17,930

Table XXI. -- Comparison of Annual Growth with Annual Depletion of Timber, by Forest Cover Types and Kinds of Products, in the Hardwood and Prairie Districts of Minnesota, 1934-1944

Forest cover type	Saw timber		Pulpwood		Total volume	
	Growth	Depletion	Growth	Depletion[1]	Growth	Depletion
	M bd.ft. Scrib.	M bd.ft. Scrib.	Cords	Cords	M cu.ft.	M cu.ft.
Pine:						
White pine	280	417	.....	.....	300	213
Norway pine	460	326	.....	.....	400	157
Jack pine	340	303	1,000	.....	210	149
All pine	1,080	1,046	1,000	.....	910	519
Upland hardwoods:						
Maple-basswood	16,680	27,504	2,000	.....	12,900	15,282
Oak	17,660	17,891	3,000	1,000	12,900	14,313
All upland hardwoods	34,340	45,395	5,000	1,000	25,800	29,595
Bottomland hardwoods	10,500	9,694	3,000	1,000	6,270	6,087
Spruce-balsam	630	810	1,000	1,000	430	477
Coniferous swamp:						
Spruce	1,060	381	7,000	6,000	1,160	772
Tamarack	1,110	1,016	5,000	1,000	1,310	1,493
Cedar	200	231	1,000	.....	380	290
Nonproductive	20	7	5,000	4,000	780	538
All coniferous swamp	2,390	1,635	18,000	11,000	3,630	3,093
Miscellaneous:						
Aspen-birch	8,300	5,228	28,000	16,000	12,980	11,775
Scrub oak	2,500	3,059	1,000	.....	4,200	6,437
Deforested	4,640	6,523	1,000	.....	4,230	4,537
All miscellaneous	15,440	14,810	30,000	16,000	21,410	22,749
All cover types	64,380	73,390	58,000	30,000	58,450	62,520

[1] Includes cut of pulpwood from cordwood trees and from tops and limbs of saw-timber trees, but not the volume of sawlogs cut for pulp, which is included in the saw-timber column.